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THE ROLE OF PERCEPTUAL INFORMATION IN TACHISTOSCOPIC WORD IDENTIFICATION

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THE ROLE OF PERCEPTUAL INFORMATION IN TACHISTOSCOPIC WORD IDENTIFICATION

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THESIS

THE ROLE OF PERCEPTUAL INFORMATION IN TACHISTOSCOPIC WORD IDENTIFICATION

(Summary)

Although word frequency, word length and context have been shown to affect word recognition threshold, there has been much debate regarding the extent to which these variables affect the utilization of perceptual information received by the observer from the tachistoscopic stimulus. The major difficulty in assessing the role of perceptual information in word recognition has been shown to lie in the use of the Ascending Method of Limits for threshold determination. With the use of this method, the contribution of perceptual information to word recognition threshold cannot be separated from the role of other sources of information.

The problem with which this thesis was concerned was an evaluation of the role of perceptual information in tachistoscopic identification of verbal stimuli. Perceptual information was varied in terms of three quantitative characteristics of verbal stimuli; word frequency, word length and the presence or absence of context. Three experiments were carried out in which the frequency of correct response as a function of exposure duration was determined for words varying in frequency of occurrence in language usage, length and appearanee on the presence or absence of context. A forced-choice method was used in order to permit a separate analysis of the influence of perceptual information upon tachistoscopic identification of words.

The first experiment examined the effects of word frequency upon perceptual identification of words as a function of exposure duration. It was found that perceptual identification of words increased as word frequency increased as a direct function of exposure duration. These data were interpreted to mean that the utilization of perceptual information by the subject in the tachistoscopic task depends upon word frequency and exposure duration.

The second experiment investigated the role of word length upon perceptual identification of words as a function of exposure duration. Perceptual identification of words was seen to increase as word length decreased for all levels of exposure duration. The utilization of perceptual information was shown to depend upon word length.

The third experiment evaluated the effects of verbal context upon perceptual identification of words as a function of exposure duration. It was found that performance in the presence of context does not differ from performance without context. It was concluded that context does not affect the utilization of perceptual information and hence does not affect perceptual identification of words.

These findings provided grounds for questioning the earlier assumptions about the role of word frequency, word length and verbal context in word recognition. The studies demonstrated the necessity for separating and analysing the various sources of information available to the observer in the tachistoscopic recognition task. It was pointed out that the main contribution of this research lies in the empirical demonstration of the effects of perceptual information varied in three ways upon tachistoscopic word identification and in the application of the forced-choice technique to the study of perceptual process.

BIOGRAPHY

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INTRODUCTION

The subject of this thesis concerns the perceptual identification of tachistoscopically presented verbal material. Perceptual identification refers to the identification of verbal stimuli solely on the basis of experimentally controlled perceptual stimulus information. Many experiments in the past have examined tachistoscopic identification of verbal stimuli, but the role of perceptual information, as distinct from other sources of variance contributing to differential identification, has rarely been evaluated. The major purpose of this thesis is to separate and assess the effect of perceptual information upon the tachistoscopic identification of verbal stimuli.

The effects upon tachistoscopic recognition of several variables characterizing verbal stimulus materials have been studied extensively in recent years. The term recognition has generally been used to refer simply to the correct identification of verbal stimuli. It will be noted that the definition of this term does not specify what sources of information are utilized by the observer for word identification. Throughout this report, the term perceptual identification of words will refer to identification determined by perceptual information alone. The term recognition however, will be used to refer to tachistoscopic identification in situations where the sources of information are not separately defined or controlled. The data from experiments on recognition have generally been regarded as providing information about the nature of perceptual process. Some recent experimental work however, has cast doubt upon the frequently held view that tachistoscopic recognition of words illuminates our knowledge of the

process of perception.

The major difficulty in assessing the function of perceptual information in tachistoscopic word recognition results from the traditional technique employed in the measurement of word identification. The ascending method of limits (AML) is typically used. Exposure duration or illumination of the verbal stimulus is systematically increased until congruence between the observer's verbal response and the visual stimulus presented is attained. From such congruence, the reception and utilization of perceptual information is inferred.

The validity of such an inference is open to question. Simply to show that correct word recognition occurs at a particular exposure duration or illumination level does not necessarily indicate the reception and utilization of perceptual information. Obviously, in many cases perceptual information is relevant but the extent to which the observer's report is determined by perceptual information alone cannot be specified. Other sources of variance such as previously learned response tendencies or biases may interact in some complex fashion with perceptual input to affect word recognition. The extent to which word recognition is influenced by perceptual information can only be examined in experimental situations in which other sources of potential influence are controlled.

The present research was carried out in order to evaluate the role of perceptual information upon the perceptual identification of words. Perceptual information was varied in two main ways; (a) in terms of exposure duration, and (b) in terms of variables characterizing the verbal stimuli. The relations between exposure duration and perceptual identification

of words varying in frequency, length and presentation in linguistic context were examined in a series of experiments. A variation of the forced choice method instead of the AML was used in order to permit an assessment of the variables affecting perceptual identification of words.

HISTORICAL REVIEW

Almost no experimental evidence regarding the relative contribution of perceptual information to identification of tachistoscopic verbal stimuli has been presented in the literature. However, several experiments have been conducted in which the relation between recognition threshold determined by the AML and a variety of stimulus variables has been established. A review of the research in word recognition will serve to summarize existing experimental evidence and to clarify the difficulties encountered when perceptual identification of words is inferred from recognition threshold data.

It will be remembered that perceptual identification of words refers to the identification of verbal stimuli solely on the basis of perceptual information. Word recognition and recognition threshold will refer to the identification of verbal stimuli without specification of determining sources of variance. Further, recognition threshold will imply the use of the AML for threshold measurement since all the researches in recognition threshold reported in the literature have employed this technique.

The first part of this section will examine the use of exposure duration as an independent variable. The second segment will discuss the relation between recognition threshold for verbal stimulus and stimulus frequency. The third part will examine the experimental findings regarding the relation between recognition threshold and word length. The effect of verbal context upon word recognition will be discussed in the final portion of this section.

Exposure Duration

In the usual tachistoscopio experiment, the AML has been used to determine recognition threshold. Threshold measured by this technique is defined as the minimal exposure duration of the stimulus necessary for elicitation of correct identifying responses. (eg. Cofer & Shepp, 1957; Howes & Solomon, 1951; King-Ellison & Jenkins, 1954; McGinnies, Comer & Lacey, 1952; Neisser, 1954) Exposure duration therefore is typically regarded as the dependent variable and expressed as some function of a manipulable stimulus variable.

Exposure duration was first employed by the early investigators in expressing the briefest stimulus exposure necessary for the identification of stimulus materials. In other words, exposure duration was used as the typical dependent variable and expressed as some funotion of the stimulus or situational variables under examination of measurement.

Exposure duration can also be used as an independent variable. The effect of such manipulation can be noted upon such measures as frequency or proportion of correct identifications. This method has not been used extensively and hence little information regarding the effeots of exposure duration upon tachistoscopic identification is available.

Miller, Bruner & Postman (1954) have shown that percentage of correct letter identification increases as exposure duration increases. Lawrence & Coles (1954) have demonstrated that percentage of correct responses to pictorial stimuli is a positively accelerated function of increasing exposure duration. Teichner & Sadler (1962) found that percentage of correct identification of alphabetic letters which varied in number of categories

and letter density is a negatively accelerated increasing function of exposure time. Baumal (1962) has also shown that proportion of correct tachistoscopic identification of words seen in the presence of verbal contexts increases with increasing exposure duration. Sperling (1960) however, did not find a relation between number of letters recalled correctly and exposure duration. It is to be noted that Sperling's task differed from that of the usual tachistoscopic task in that he required the subject to give only partial reports of letters seen. So too, Sperling (1960) employed dark pre and post exposure fields in the tachistoscope in contrast to the usual tachistoscopic study which uses bright fields.

The weight of evidence seems to indicate that a direct increasing relation between exposure duration and frequency of correct response exists. Tachistoscopic exposure duration, in the research reported in this thesis, will be regarded as a means for manipulating the availability of perceptual information. As exposure duration increases, it is assumed that available perceptual information increases and hence the frequency of correct perceptual identification of verbal stimuli will increase.

Word Frequency

The last decade has seen a great deal of experimentation on the relation between word frequency and recognition threshold for words. This research grew out of earlier attempts to assess the role of personality or motivational variables in word recognition. In order to explain the empirical finding that words have different thresholds and in order to circumvent the necessity for the postulation of complex unobservable mechanisms operating at subthreshold levels, Howes & Solomon (1951) undertook the task of re-examining the phenomenon of differential word recognition. They pointed out that relations can be determined between any measure of word recognition such as duration threshold and any measurable property of words.

> "Any general property of words, then, should be operative in the word threshold experiment, and the dependent variable (duration threshold) some function of it." (p. 401)

Howes & Solomon (1951) chose to begin their examination of word recognition by determining the relation between recognition threshold for words and the linguistic variable of frequency of occurrence of word stimuli estimated from standard word counts for the English language. Several other investigators (McGinnies, Comer & Lacey, 1952; Postman & Conger, 1954; Postman & Schneider, 1951; Solomon & Howes, 1951) have replicated the Howes & Solomon (1951) study. The results of all these studies have been consistent. Word recognition threshold approximates a linear, decreasing function of the logarithm of the frequency of occurrence of words in English.

The index of word frequency (Thorndike & Lorge, 1944) employed

in the experiments just mentioned allows only a rough estimate of the relative frequency of word occurrence for the individual subject. Several experimenters (Baker & Feldman, 1956; King-Ellison & Jenkins, 1954; Postman & Rosenzweig, 1956; Solomon & Postman, 1952) sought to gain better control over the frequency variable. Levels of word frequency were experimentally established through differential pre-training with linguistic units. Threshold for these stimuli were then measured. Again, the results were highly consistent. Word recognition threshold was shown to bear an inverse relation to the experimentally established word frequencies. Regardless of the method used to quantify word frequency, the weight of evidence confirms the role of word frequency in lowering word recognition threshold.

The interpretations of these findings generally include the assumption that word frequency, however it is defined, affects the perceptibility of linguistic stimuli. Because recognition threshold for high frequency stimuli is lower than threshold for low frequency units, it is assumed that high frequency stimuli are more visible.

> "The more frequently a word is used in the language, the more readily it can be seen". (Rosenzweig & Postman, 1958, p. 265)

Postman & Rosenzweig (1956) state this interpretation again but in a slightly different fashion. They

> "...consider speed of recognition a function of the amount of discrimination required for correct identification of stimulus items"(p. 223)

Howes & Solomon (1951) and Solomon & Howes (1951) do not state this assumption explicitly. They argue that frequency of past use of linguistic

units results in differential response strength. Such differences in the response strength of verbal stimuli lead to differences in speed of recognition. Perceptual sensitivity favouring the visibility of high frequency stimuli is thus inferred from differential threshold for words.

The major obstacle in testing this inference lies in the experimental method used in measuring recognition threshold of words. It is difficult to evaluate the extent to which perceptual information determines what the observer reports he sees by the use of the AML to establish threshold. This problem becomes obvious when the method is examined closely. At very brief exposure durations, the observer may see nothing but a blur. He may hazard a guess or more likely say nothing. As exposure duration is systematically increased, the probability that the observer sees some fragment of the stimulus increases. On the basis of some partial information, he may venture a guess which may or may not be correct. If his response is incorrect, duration is increased and hence perceptual information is increased until the observer emits the correct response.

As exposure duration is increased, a shift occurs in the amount of the perceptual information available to the subject (Bricker & Chapanis, 1953). So too, as information input increases, the subject's dependency on other sources of information necessarily decreases. The extent to which the verbal response is determined by the perceptual information is unknown. The role of other variables such as learned linguistic habits is unknown also. Threshold determined by the AML allows the experimenter to record only a congruence between the stimulus presented and the response emitted. Such

a correspondence does not necessarily demonstrate the effect of perceptual information or the operation of perceptual process (Goldiamond, 1958).

Goldiamond & Hawkins (1958) challenged the perceptual interpretation of the word frequency effect upon recognition threshold. They argued that word frequency may influence only the verbal report of the observer. However, when the AML is employed to measure recognition, the artifactual effect of differential threshold may be obtained.

> "Recognition involves accuracy, and accuracy is usually regarded as the congruence between S's responses and the stimulus sequence... If words more frequently used...are also the more frequent responses in a recognition session and if in the session words appear equally on E's score sheet, then the frequent words will score more hits than the infrequent words. The frequent words should also produce such congruences earlier in the series. If as in the ascending Method of Limits, a hit terminates the series, and ascending energy values are assigned to successive presentations in the series, then recognition thresholds of more frequent words should be lower than those for less frequent words". (p. 458)

Goldiamond & Hawkins (1958) carried out an experimental test of these notions. Differential frequencies of nonsense syllables were established in a pre-training session. The experimenters then purported to measure thresholds for the nonsense stimuli. In fact, the experimenters presented no stimuli to the observers in the tachistoscope, just a flash. Subjects were told however that stimuli were presented and to guess at the word stimuli until they correctly identified the syllable. Correct identification was defined as responding with the word that appeared on the experimenters' score sheet which contained all syllables presented with different frequencies in the training session. Even though words appeared with different frequencies in the pre-training session, they appeared

equally often on the experimenters' tally sheet. The AML was mimicked, with correct response to so-called exposures terminating the series of exposures.

An inverse relation between syllable frequency and "recognition threshold" was obtained. These results thus duplicated the findings of the studies in which word or syllable stimuli of different frequencies were actually presented tachistoscopically. Since the same relation was obtained in the absence of perceptual information, Goldiamond & Hawkins (1958) argued that the frequency-threshold relation cannot be ascribed to effects of frequency upon perceptual process.

Even though this demonstration of the effects of word frequency upon verbal report is valuable, these findings should not be interpreted as proving that verbal report is affected by the frequency variable and that perception is not. Simply to show that frequency plays a significant role in verbal response is not to deny its effect upon the input of perceptual information and hence its influence upon perceptual process under conditions where stimulus information is available. Experimental situations are necessary in which the effects of frequency upon the reception and utilization of perceptual information are allowed to vary while its effect upon other sources of variance such as response tendencies is limited. If, in these situations, perceptual identification of high and low frequency words does not differ, only then can we exclude the role of perceptual information manipulated in terms of frequency in word identification.

To the best knowledge of the writer, only one study exists in the literature in which an attempt has been made to evaluate the effects of frequency upon the perceptual identification of words. Goldstein & Ratleff

(1961) utilized both spatial and temporal forced-choice methods (Blackwell, 1953) to determine the role of word frequency in perceptual identification. The use of these methods permitted the control of the effects of frequency upon response tendencies which appear to have some effect upon recognition threshold. Subjects were first given differential prior training with a number of three letter nonsense syllables in order to establish four levels of experienced word frequency. Subjects were then required to specify in which of four temporal or spatial locations in the tachistoscopic field a particular word appeared. Since stimuli at all levels of frequency were presented on each trial and spatial and temporal positions as well as specific word identifications were presented equally often, an assessment of the effect of word frequency upon word identification could be made. On the basis of chance alone, that is, the absence of perceptual information the observer could have made correct identification on approximately 25 percent of the presentations. If any difference in performance between high and low frequency words appeared at levels above chance performance, then frequency must necessarily affect perceptual information input differentially.

Goldstein & Ratleff (1961) found no difference in perceptual identification of high and low frequency stimuli. They concluded that

> "The results of the two forced choice studies tend to confirm Goldiamond & Hawkins' (1958) contention that the frequency of usage-ease of recognition findings are largely due to response bias". (p. 176)

However, they very carefully followed this statement with a brief discussion of the limitations of their research. First, they pointed out

that their use of a single exposure duration level may not be adequate to demonstrate the effects of frequency upon perceptual identification of words. They suggested that the use of the forced-choice technique coupled with a series of exposure duration values is necessary before the effects of frequency upon word identification can be determined.

The second limitation of the Goldstein & Ratleff experiment concerns the use of experimentally established word frequencies.

> "...the degree of experience which has been manipulated is extremely limited in comparison to the degree of practice which people have in using verbal stimuli during the course of their lifetimes. It is conceivable that a high degree of discrimination training is required before selectivity in perception can be noted. Other experiments of the present type using stimulus materials of higher meaningfulness and providing greater amounts of training experience would be extremely valuable in clarifying this point". (p. 176)

In essence then, the problem of the role of word frequency in perceptual identification of words has been recognized. One attempt to examine the effects of frequency upon perceptual information input has been made, but the issue is far from settled. It was the purpose of the first experiment of this report to investigate the effects of word frequency upon perceptual information and hence perceptual identification of words.

Word Length

Several investigators have examined the effect of certain structural or physical characteristics of words upon their recognition threshold. Howes & Solomon (1951) have shown for example that when word frequency is held constant, letter shapes, length of syllables within words,

repetitive letter sequences and the case in which the letters of words are printed influence threshold. This knowledge is hardly new. The notions of "total word picture" (Cattell, 1885) and "general word shape" (Erdmann & Dodge, 1898) were used many years ago to describe the major determinants of word recognition. The general external configuration of the word which varies with length, the internal characteristics of differential letter shapes and the few letters on either side of the point of visual fixation were thought by the early investigators to be the primary cues for word recognition.

More recently, the relation between word recognition threshold and word length has received renewed attention. In the well-known study of the word frequency-recognition threshold relationship, Howes & Solomon (1951) reported that

> "The length of a word did not appear to affect our thresholds". (p. 409)

Howes & Solomon's conclusion regarding the lack of relationship between word length and word recognition threshold was questioned by McGinnies, Comer & Laoey (1952). Their experiment was carried out in order to isolate the effects of both word length and word frequency upon recognition threshold for words. The results clearly indicated that word recognition threshold is a linear decreasing function of word frequency as previously found by Howes & Solomon (1951). However, in opposition to Howes & Solomon's contention that word length had no effect upon threshold, McGinnies et al (1952) found that recognition threshold is a linear increasing function of word length. Further, these investigators found a

significant interaction between word frequency and length.

> "The significant interaction between frequency and word length can be described as follows: a) an increase in frequency lowers thresholds of long words more than short words, b) longer words are accompanied by higher recognition thresholds to a greater extent in the case of low frequency words than in the case of high frequency words. In short, one cannot state the precise effects of either word frequency or word length upon thresholds of visual recognition without considering the interaction between the two". (p. 68)

Newbigging (1961) has confirmed the finding that long words have higher recognition threshold than short words, but reported that this effect appeared only when relatively infrequent words were utilized as stimuli. In another recent study by Cochran (1962) the results failed to show a significant correlation between word length and recognition threshold. However, in view of the McGinnies et al experiment (1952) and the study by Newbigging (1961), this result is not very surprising since the words employed in the Cochran (1962) study were selected from among relatively frequent words in English.

The effects of word length and its interaction with word frequency in influencing recognition threshold was forecasted in the very early tachistoscopic investigations. While the major purpose of the early studies was directed towards the study of reading, some of the findings bear upon current work. For example, Cattell (1887) in his reaction time experiment found that the time interval between the exposure of the stimulus and the beginning of the oral response was greater for long words than for short words. Cattell also found that short familiar words were read as quickly as single letters. In tachistoscopic experiments, Cattell (1885) found that greater numbers of letters in words could be recognized than in

sequences of unconnected letters. Erdmann & Dodge (1898) confirmed Cattell's (1885) findings. They demonstrated that in brief tachistoscopic exposures, only four or five unconnected letters could be reported correctly. During longer exposures, with constant fixation, the limit of correct identification of letters was approximately six or seven letters, two or three on each side of the point of fixation. However, with familiar words as long as twelve to twenty letters, correct identification of words occurred with relatively brief exposures.

Although some experiments have been reported which directly investigate the effect of word length on recognition threshold, the question regarding the effect of length upon perceptual identification of words has not been examined. It is known for example, that perceptual identification of single letters or pairs of letters decreases as the distance of these letters from the point of fixation in the visual field increases due to diminished visual acuity in the retinal periphery (Ruediger, 1905; Woodrow, 1938). However when several letters are presented simultaneously, as in words of various lengths (but at the same frequency level), it is unknown to what extent length affects perceptual information and hence perceptual identification of words.

There is some experimental evidence that indicates that length or number of stimulus units interacts with other non-perceptual processes. The experiments by Sperling (1960) showed that observers actually see more than they are able to report. In other words, the effects of memory inhibit the report of the reception and utilization of perceptual information, even

though differential length or number of stimulus units may play a small role in perceptual identification. An experiment by Teichner, Reilly & Sadler (1961) offers further evidence to support the notion that verbal report of visual stimulation is inhibited by memory. They found that visual identification is a function of both perceptual information and short term memory. Like Sperling (1960), they stated that differential recognition in terms of number of units presented for identification is due to the limitations of the capacity for short term memory rather than the limitations of perceptual process.

It must be pointed out that in both the Teichner et al study (1961) and Sperling's (1960) experiments, subjects were not asked to identify words, but patterns of letters and numbers. Since the perceptual units were not structured in any meaningful way, memory may assume a more important role in the verbal reproduction of such visual stimulation.

If long words are more difficult to perceive and the observer receives only partial information from a presentation of short duration, longer exposure may be required before he receives enough information for correct identification of long words. If perceptual information does vary with length, then perceptual identification of words should differ as a function of exposure duration of the stimulus. However, if short term memory and other processes affect word identification in the same or similar way as they affect identification of isolated units, then little or no difference should result when perceptual identification of words is measured in situations where only the perceptual information is permitted to vary.

At this time, the role of word length in perceptual identification of words is largely an empirical question. It is known that word length and recognition threshold covary with words of relatively low frequency of occurrence in language. It is not known to what extent the manipulation of length affects the perceptual information provided for the subject in a word identification task. The second experiment of the present research was an attempt to evaluate word length as a variable affecting perceptual information and hence the perceptual identification of tachistoscopically presented verbal material.

Verbal Context

The present interest in the effect of verbal context upon perceptual identification of words emerged from some earlier work carried out by the author (Gold, 1960). Gold's study was designed to investigate the hypothesis that recognition threshold for words reflects the amount of information transmitted by tachistoscopic word stimuli, Stimulus information of words was defined in terms of the quantitative characteristics of pre-exposure verbal contexts in the presence of which word stimuli were tachistoscopically presented to subjects.

Two kinds of contexts varying in length were used to manipulate stimulus information. Relevant verbal contexts consisted of parts of English sentences in which the tachistoscopic word stimulus assumed the final position. Irrelevant contexts were similar sequences but bore no meaningful relation to the stimulus word. Word recognition threshold was shown to decrease with increasing length of relevant context and to in-

crease with increasing length of irrelevant pre-exposure context.

It was argued by Gold (1960) that increasing the length of relevant context decreased the number of suitable words appropriate to the context and hence increased the probability of the occurrence of correct verbal response. Increasing the length of irrelevant context served to decrease the predictability of the correct word and hence decreased the probability of its occurrence as a response. In information theory terms, the greater the probability of the occurrence of a response, the smaller the amount of information transmitted by its occurrence. The converse of this statement implies also that the smaller the probability of the occurrence of a particular response, the larger the amount of information transmitted by its occurrence. Therefore the findings were interpreted as indicating that word recognition threshold is a function of the amount of information conveyed by the stimulus word.

It will be noted that Gold's (1960) study indicates only that recognition threshold for words varies as a function of the information content of the tachistoscopic stimulus. The obtained relationship does not give any indication regarding the extent to which the stimulus information determined word recognition. In fact, since the concept of response probability implicit in the definition of stimulus information employed by Gold (1960) was utilized to predict and explain differential threshold, her results may be less applicable to perceptual identification than to the subject's ability to predict words in context without any perceptual information.

It has been shown that correct letter prediotion in the absence

of perceptual information increases as knowledge of the foregoing text is extended from zero to thirty-two letters (Burton & Licklider, 1955). Aborn, Rubenstein & Sterling (1959) have demonstrated that word predictability increases as length of context increases up to a limit of ten words. The maximum effectiveness of context upon word prediction was shown to lie between five and ten word contexts. Guessing behavior of subjects based on past language experience may influence the emission of the correct word in context in the tachistoscopic situation. Perceptual information may play less of a role in such a task than language habits of the observer.

In other words, the contexts of various lengths and the response tendencies evoked by them may be a sufficient condition for the elicitation of the correct verbal response in the tachistoscopic task. However, the influence of perceptual information in terms of the presence or absence of verbal context upon perceptual identification of words is not necessarily excluded. The question regards the magnitude of the effect of perceptual information upon word identification when perceptual information is defined in terms of contextual conditions.

In a recent experiment by Cuddy (1961), an attempt was made to assess the relative contribution of perceptual information manipulated by the use of relevant and irrelevant contexts of different lengths to word recognition threshold. The same contexts and conditions used by Gold (1960) were employed by Cuddy. Subjects were told in advance of tachistoscopic presentation of word stimuli to ignore the irrelevant or pay attention to the relevant context seen in the pre-exposure field. Cuddy argued that in

Gold's study irrelevant context set the subject to respond with a class of words. This implicit set interferred with the recognition of the tachistoscopic stimulus word and hence produced higher thresholds. However, by telling subjects that contexts were irrelevant or relevant to the stimulus word, Cuddy argued that the effect of context upon perceptual identification of words could be evaluated. If under these conditions no difference in threshold between words seen in relevant and irrelevant context was obtained, a response interpretation was clearly indicated. If a difference was obtained, then the role of perceptual information could be affirmed.

Cuddy's results were essentially the same as Gold's. Word recognition threshold was shown to be an increasing function of the length of irrelevant pre-exposure context and a decreasing function of the length of relevant context. However, when subjects who were given irrelevant contexts were presented unknowingly with a relevant context, word recognition threshold was as low as if words were shown in contexts known to be relevant. The opposite results occurred when an irrelevant context was presented to subjects who had previously been exposed to relevant contexts. Cuddy's results therefore are inconclusive with respect to the perceptual effects of context. It appears that subjects were unable to ignore the irrelevant context. Therefore, a perceptual interpretation of the results with relevant context is not necessarily indicated, and hence no assessment of the effects of perceptual information manipulated through the use of contexts upon word identification could be made.

An interesting experiment carried out by Neisser (1954) attempted to assess the effects of context upon word identification. This study made provision for the experimental analysis of the effects of context upon perceptual identification of words as distinct from contextual effects upon verbal response. Neisser (1954) presented subjects with pairs of homonyms. After inducing set for one member of the homonym pair, he then measured the decrease in threshold for that word and compared it with the decrease in threshold for the second member of the pair. The findings indicated that

> "...the preliminary presentation facilitated the recognition of specific items (for which sets were induced) but in no way facilitated the recognition of their homonyms. Since the same verbal response is employed in reporting a homonym as in reporting the word itself, it appears that the effect of a set of this type is to facilitate recognition processes without generally facilitating the corresponding verbal responses". (p. 402)

Goldiamond (1958) levies a cogent criticism of Neisser's interpretation. The individual members of the homonym pairs were not matched for frequency of occurrence in the language and hence Neisser's findings may be confounded by the well known effects of word frequency. Neisser's study however, does give some evidence of the recognition of the problem inherent in the use of a perceptual interpretation of recognition threshold data and provides an interesting technique for separating the perceptual aspects of recognition from other sources of variance which may affect threshold.

Two studies are reported in the literature in which single word contexts are shown to affect word recognition threshold. Cofer & Shepp

(1957) demonstrated that thresholds for words were lower when seen after exposure to words which bear synonymic relationship to the tachistoscopic stimuli than when viewed after exposure to unrelated words. In the same vein, O'Neil (1955) has shown that recognition of words is facilitated after exposure to words associated with the stimuli.

The question concerning the effects of context upon perceptual identification of words is exactly the same as the question regarding the effects of word frequency and word length upon word identification. Does context vary the amount of perceptual information conveyed by a stimulus word and hence affect its perceptual identification? The third experiment reported here was carried out to assess the effect of the presence and absence of context upon perceptual identification of tachistoscopically presented words.

STATEMENT OF THE PROBLEM

Many experiments in the past have examined tachistoscopic identification of verbal stimuli. The relations between recognition threshold for words and word frequency, word length and verbal context have been determined, yet little is known regarding the extent to which thresholds are determined by these variables. The difficulty in assessing the contribution of these variables to perceptual identification results from the use of the AML for threshold measurement. This method does not permit an evaluation of the role of perceptual information alone in tachistoscopic identification.

The problem of this thesis was to separate experimentally and assess empirically the effects of perceptual information upon tachistoscopic identification of verbal stimuli. Perceptual information was varied in two main ways; a) in terms of tachistoscopic exposure duration and b) in terms of variables characterizing verbal stimuli. A forced-choice method which permits the separation of the role of perceptual information from other sources of information affecting word identification was employed.

The first experiment examined the relation between ease of perceptual identification of words and word frequency as a function of exposure duration. The second experiment dealt with the relation between perceptual identification of words and word length at various exposure durations. The third experiment was carried out in order to evaluate the ease of perceptual identification of words seen in the presence and absence of verbal context as a function of exposure duration.

GENERAL METHOD

Forced-Choice Method

It has been pointed out earlier that the measurement of recognition threshold for words typically has involved the use of the AML. The experimenter systematically increases stimulus energy until the subject makes the required response. The level of stimulus energy at which the subject makes the correct response is taken as recognition threshold.

Goldiamond (1958) has shown that although the combination of the AML and accuracy indicator of the response appear to have great face validity for the study of perceptual process, in fact, such measurement of threshold may provide little or no information about perceptual process and the variables affecting its operation. Goldiamond in fact has suggested that differential word recognition can be accounted for on the basis of response habits alone. An ingenious experiment discussed earlier (Goldiamond & Hawkins, 1958) has provided some evidence for this contention. It must be remembered, however, that the sufficiency of the response interpretation of perceptual data offered by Goldiamond & Hawkins (1958) must be limited, at least for the time being, to the very restricted experimental conditions employed.

Goldiamond's analysis (1958) of response indicators in tachistoscopic experiments offers some insight into the difficulties inherent in the assumption that recognition threshold is a measure of perceptual identification. Accuracy of stimulus identification in recognition threshold studies is almost always defined in terms of the congruence between the observer's response and the item on the experimenter's data sheet. The

observer comes to the perceptual task with a well established hierarchy of response habits, or in Goldiamond's terms, response biases. These response biases may interact with the reception and utilization of perceptual information provided in tachistoscopic presentation of the stimulus. An example of how such interaction affects the outcome of experiments on perceptual defense is offered by Goldiamond. At energy levels where some perceptual information is available,

> "A couple of letters discriminated may provide the occasion for a response which has previously been reinforced under similar conditions....If this response has a higher probability than others, and this bias will lead to quick congruence, S will display sensitization effects. If S's bias does not agree with the score sheet, there may be defense effects". (1958, p. 398)

Obviously, in the tachistoscopic situation, perceptual information played some role. The question is not necessarily one of either a response interpretation or a perceptual inference. Rather, the problem concerns the relative contribution of the two processes to threshold determination, but the AML does not permit the separate analysis of the various sources of information affecting word identification.

Blackwell (1953) in his work in the measurement of sensory thresholds by psychophysical methods developed a technique which allows for control of variables extraneous to the task of sensory discrimination. This technique is the forced-choice method.

> "Forced-choice is defined by two conditions: a) The subject is required to indicate discrimination by identifying some attribute of the stimulus other than its magnitude. Attributes such as location in space or occurrence in time may be used; b) The subject is forced to record a choice for each stimulus presentation". (p. 7)

In essence, what the forced-choice method does is to control for the tendency of subjects to use certain responses more frequently than other responses in indicating awareness of perceptual stimuli. The method controls for the spurious coincidence between the subject's response and the experimenter's data sheet that may occur when an accuracy indicator is used. Since the forced-choice method permits the specification of the level of chance coincidence between stimulus presentation and the observer's correct report the role of perceptual information in determining the observer's response can be separated from that of response bias.

Blackwell's (1953) forced-choice technique can be adapted for the study of the perceptual identification of verbal stimuli as follows. An observer is presented with four words before the tachistoscopic task begins. He is told that one of these four words will appear briefly on each exposure and that he is to specify which one of the four words appeared. He is also told that each of the four words will be presented equally often over a series of exposures. If the words are presented for a very long interval of time, the subject will always be able to identify them. The probability of correct response under this condition is obviously unity. At the other extreme of the exposure time continuum, at an exposure duration of zero, the observer receives no perceptual information. However, since he is forced to choose one of the four words as a response, the probability of correct response in the long run will approximate what would be expected by chance, .25. Between these two levels of exposure duration and their attendent probabilities of correct

response must lie a series of probabilities each associated with a particular exposure duration. The curve connecting these points indicates the influence of perceptual information received by the subject through tachistoscopic exposure of stimuli upon the probability of correct response.

The important point of the forced-choice method is that the subject is forced to respond with one of the four words on each exposure. Since each of the four words is presented a number of times, but equally often at each exposure duration level, the subject will obtain approximately twenty-five percent of the responses correct even in the absence of any perceptual information. Thus, if the observer does not receive any perceptual information, his percentage of correct response cannot possibly exceed chance level. It does not matter if the subject has a particular bias for the emission of one or more of the four word alternatives. It makes no difference what response or guessing strategy the subject employs. Whenever the observer's performance exceeds twenty-five percent correct word identifications under the conditions of forced choice, such an increase must necessarily be attributable to the reception and utilization of perceptual information conveyed by the stimulus. The forced-choice method and the logic underlying its use was employed in all the experiments reported. A description of the details of the technique follows.

Different sets of four words from which the subject had to choose one word as a response to perceptual stimulation were used throughout the experiment. Each word in a given set was presented tachistoscopically equally often at various exposure durations. Specifically, at a particular

exposure duration each word in the set was shown ten times. Therefore forty tachistoscopic presentations of the words in the set were given and the observer required to make forty responses at each level of exposure duration. The order of words in the series of forty presentations was determined randomly. Since each of the four words in a set was presented equally often at each exposure duration chance level of correct response was ten correct verbal responses. Frequencies of correct response above ten thus provided estimates of the effect of perceptual information.

This basic method was used throughout all experiments. The experiments differed with respect to the independent variable studied. In the first experiment, the effect of word frequency upon perceptual identification of words was examined. The second experiment was designed to evaluate the effects of length upon perceptual identification of words. The final study investigated the effects of verbal context upon perceptual identification of words.

Apparatus

A Harvard mirror tachistoscope was mounted in a wooden screen with E and S on opposite sides of the partition. The pre-exposure field contained the point of fixation in the place of which word stimuli appeared. The word stimuli appeared in the exposure field. The length of exposure of word stimuli was controlled by an attached continuously variable timing device. Possible exposure values ranged from zero to one second. The dial

of the timer was calibrated in ten millisecond units. When the timer was activated, illumination of the pre-exposure field was terminated and the exposure field containing the word stimulus became illuminated for the selected interval. Illumination of the pre-exposure field occurred automatically upon termination of illumination of the exposure field. The level of illumination of the pre-exposure field as measured with the MacBeth illuminometer was 3.69 apparent foot candles while that of the exposure field was .54 apparent foot candles throughout all experiments. The two illumination levels were selected to obtain a range of exposure durations over which identification of words occurred gradually.

Subjects

Five female undergraduates at the University of Toronto served as volunteer observers for all the experiments. These Ss were given extensive training in tachistoscopic identification prior to the beginning of the experimental sessions. Trained Ss were used in order to control for the effects of practice which have been shown to influence recognition threshold for words (Blackwell, 1953; Cochran, 1962; Newbigging, 1961). The use of trained observers necessitated a limited number of Ss.

Preliminary Tachistoscopic Training

Four one-hour practice sessions were scheduled for each S. During each session, four hundred stimulus presentations were given and four hundred responses were recorded for each S. The forced-choice method

described earlier was employed. The training sessions served two purposes. First, the sessions provided Ss with the opportunity to become familiar with the general experimental procedure. A description of a typical experimental session follows.

On S's arrival in the laboratory, she was handed a card on which appeared the word sets that were to be presented in the session. S studied the words as long as she wished and was permitted to re-examine the words on the card at any time during the experimental session. S knew that her task was to state on each exposure which of the four words in a designated set appeared in the tachistoscope. She also knew that each word in the particular set would be presented ten times in random order at a given level of exposure duration. Before presentation of the stimulus word, a verbal warning was given to S. When S answered "ready", the word stimulus was presented. S then responded with one of the four words after each exposure. After twenty responses, S was given a short rest period of forty-five seconds. Word exposures were then continued until S made twenty more responses and again a rest was given. This method of exposure was carried out until S made the necessary number of responses required by the design of the particular experiment. By the end of the four training sessions, Ss were quite familiar with the procedure and their task. No additional formal instructions during the experiments were necessary.

The second purpose served by the training sessions was the determination of a series of exposure durations for each individual S over which correct word identification gradually increased. The lowest

exposure duration for each S was that level at which performance just exceeded chance level. The highest exposure duration represented that level at which performance reached at least seventy-five percent correct responses, but was less than perfect. For some Ss the range extended over five consecutive durations while for others, six levels were found to be necessary. The exposure duration range for each S for each experiment can be found in Appendix 1.

EXPERIMENT Ia

Experiment I was designed to study the role of perceptual information available to subjects from tachistoscopic exposure of words at different exposure durations. The main independent variable was word frequency. The effects of two levels of word frequency, high and low, upon perceptual identification of words as a function of exposure duration was examined. The two extremes of the frequency continuum were selected in order to determine whether manipulation of word frequency does in fact affect perceptual information. If perceptual information depends on word frequency, then differences in the number of correct word identifications as a function of exposure duration should be demonstrated by the use of the extreme levels.

Method

Verbal Stimuli

One set of four words was selected at each of the two levels of word frequency. The high frequency stimuli were six letter, two syllable English nouns selected from among the words occurring more frequently than 40 times per million words (Thorndike & Lorge, 1944). These words were CIRCLE, WONDER, GARDEN, and MOTHER. The low frequency stimuli were pseudo-words and were constructed in the following manner. High association value CVC nonsense syllables selected from Glaze's tables (as reported by Hilgard, 1951, p. 541) were randomly grouped in pairs. Each pair of nonsense syllables formed a six letter disyllable pseudo-word. Four such pseudo-words were used as the low frequency word

set. They were CUSRAD, MODRUF, HOMSAR, and PILSEM. The tachistoscopic word stimuli in all experiments were typed in capital letters with an IBM electric typewriter to insure equal spacing of letters and minimal cues from letter characteristics.

Experimental Design

Word frequency and exposure duration were manipulated and the joint effect of these variables upon frequency of correct response was examined. The forced-choice method described earlier was used to assess the effects of the independent variables upon the perceptual identification of words.

Each S was required to make 40 verbal responses to tachistoscopic stimulation at each exposure duration for both the high and low frequency words. At each exposure duration the 40 high frequency stimuli consisted of ten of each of the four words in the high frequency word set. Also at each duration level, ten presentations of each pseudo-word in the low frequency set was given. The stimuli were presented in randomly determined orders. Each S therefore gave a total of four hundred responses across the five exposure durations or four hundred and eighty responses across six exposure durations. The total number of responses depended on the number of duration levels in the S's individual range.

Three random sequences of the 40 high frequency stimuli and three random sequences of the 40 low frequency stimuli were constructed in order to control for the possible effects of memory. The order of presentation of high and low-frequency word sets and exposure durations

was randomly determined for each S across blocks of 20 stimuli. The stimuli were presented in blocks of 20 exposures with 45 second rest periods between blocks to insure that the Ss did not become fatigued. The use of randomly ordered stimulus magnitudes, in this case exposure duration, and blocks of 20 exposures has been shown to yield the most reliable threshold data (Blackwell, 1953).

This experiment was replicated three times for each of the five Ss. The stimulus materials, order of presentation of word sets and exposure durations were identical for each replication for an individual S.

Procedure

The tachistoscopic training sessions carried out before the beginning of the experiments familiarized Ss with the procedure. The same procedure described earlier was followed in every experimental session in the series of experiments. However, before every experimental session, Ss made responses to eighty practice presentations of the verbal stimuli to be used in the particular session in order to control for any warm-up effects.

Results

The number of correct responses at each exposure duration level for each of the word stimuli within each of the frequency word groups was calculated. From these calculations the total number of correct responses for each word set at each exposure duration level was obtained. The data

for individual Ss and the mean performance for all Ss are shown in Appendix II.

The graphical presentation of the results for each replication for all Ss combined is shown in Figure I. Exposure duration is plotted

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Figure I

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along the abcissa. The ordinal numbers represent the levels of exposure duration from low to high since the absolute values of duration differed among Ss. The number 1 represents the lowest exposure duration for all Ss, the number 5, the highest exposure duration for three Ss and 6 the highest value for the remaining two Ss. The ordinate indicates the mean frequency of correct response to tachistoscopic stimulation. The parameter is word frequency.

It can be seen that in the first replication the mean frequency of correct response for high frequency words is greater at every exposure duration than for pseudo-words. Further, the difference in performance appears to remain large across all exposure duration levels. When the data for individual Ss is examined, it can be seen that the variability in performance among Ss is very small. For each S, high frequency words are identified correctly more often than low frequency stimuli at every exposure duration in S's range. It appears that word frequency and exposure duration interact in their effect upon perceptual identification of words.

The data from the second replication also indicate a difference in performance between high and low frequency words. Identification of high frequency words still appears to be better than performance with low frequency words at every exposure duration. However, the magnitude of these differences appears smaller than the differences obtained in the first replication. An examination of the individual data shown in Appendix II indicates that the variability in the difference between identification of high and low frequency stimuli is very low among Ss. Since the data for individual Ss are consistent, the effect of word frequency favouring the perceptual identification of high frequency words is still indicated. However, it is clear that the magnitude of this difference diminished in the second replication.

The third graph shown in Figure I presents the results for the third replication. The difference between identification of high and low frequency words appears to be very small at every exposure duration level. The data for individual Ss also indicates small differences in performance with high and low frequency stimuli. Again, the variability in these differences is extremely small.

Figure 2 presents the mean difference across exposure duration between identification of high and low frequency words as a function of

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Figure 2

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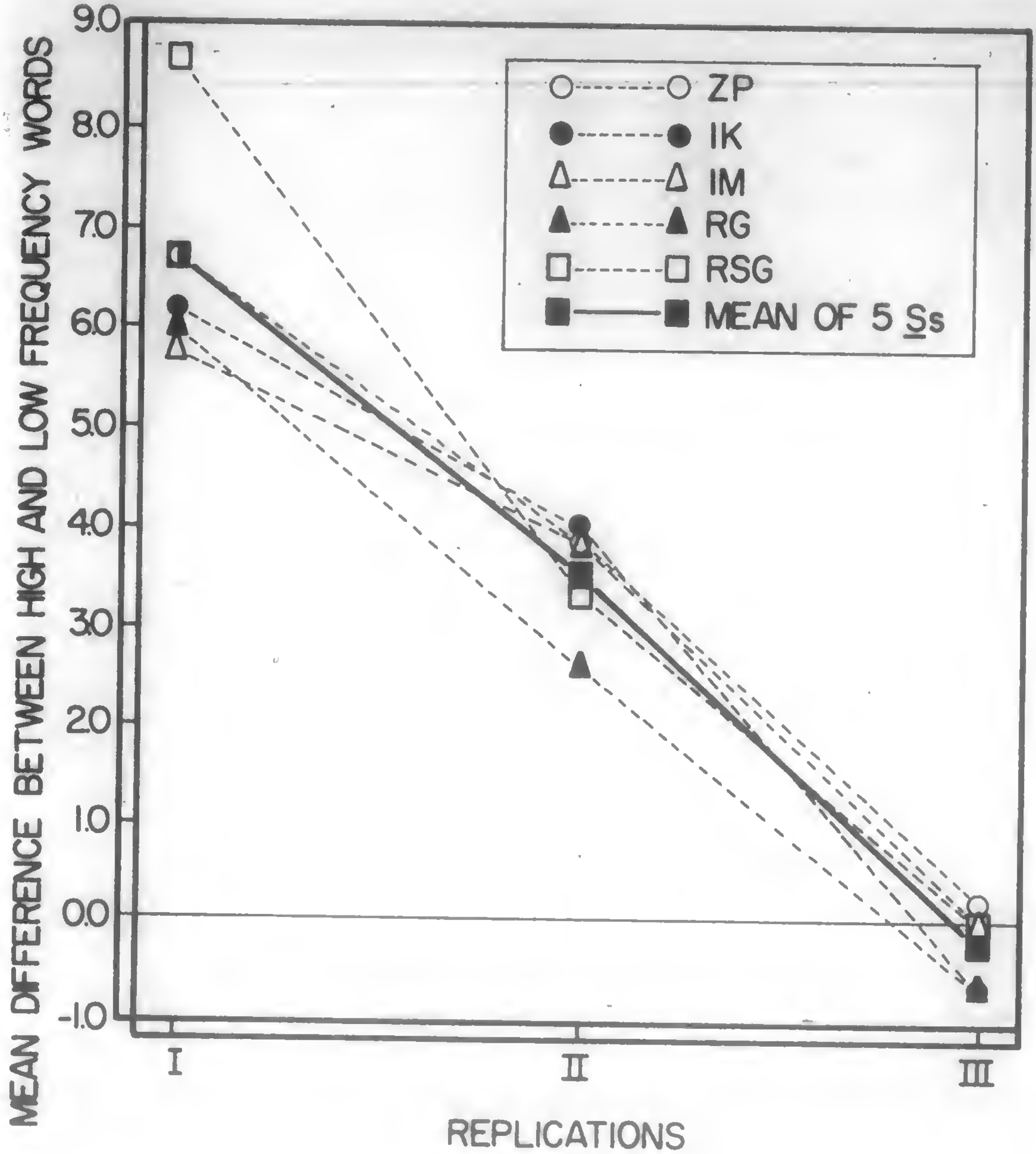
replication for each S. Also plotted is the mean performance across exposures for all Ss combined. The graph indicates the decrease in the

FIGURE 2

Mean difference in frequency of correct response between high and low frequency words across exposure duration as a function of replications. The dotted lines represent the data for individual Ss. The heavy line indicates the mean performance for five Ss.



MEAN DIFFERENCE BETWEEN HIGH AND LOW FREQUENCY WORDS
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
ZP
IK
IM
RG
RSG
MEAN OF 5 Ss
I
II
III
REPLICATIONS

difference between frequency of correct response for high and low frequency stimuli for each S as a function of replications. It can be seen that the individual data are highly consistent among Ss for each replication. The difference in perceptual identification of high and low frequency words diminishes with repeated exposure of the stimuli. There seems to be a systematic relation between amount of previous practice and perceptual identification.

Two explanations can account for the disappearance of the effect of frequency upon tachistoscopic identification of words over replications. The most obvious interpretation is that frequent exposure and S's emission of low frequency responses served to inflate the frequency of occurrence of pseudo-words so that these verbal stimuli became as frequent in the S's immediate experience as common English words. By definition, the difference in frequency diminishes with successive occurrence of the low frequency word. If frequency of occurrence of words does affect perceptual information, and hence word identification, then the results obtained in the three replications are not unexpected. One would expect the initial difference favouring the identification of high frequency words to disappear once the infrequent words approach the frequency of exposure of frequent words through successive presentation.

However, it is conceivable that frequency may not be the factor affecting the change in performance. The S's strategies in identifying the stimuli may change. Ss may realize for example, that they do not have to see the whole word in order to make the correct response. Some

Ss commented that each word in a particular word set began with a different letter. It may well be that the S realized that she needed to see only the initial letter or some other small fragment of the stimulus in order to be able to identify the word. As a consequence, the initially effective variable simply is not operative.

EXPERIMENT Ib

The second experiment was conducted to determine which alternative explanation is more applicable to the findings of Experiment Ia. If it is subjective strategies that change with practice, then testing the observers with new groups of words at the two levels of frequency should result in the same apparent lack of difference between perceptual identification of high and low frequency words. If, on the other hand, the disappearance of the difference was attributable to the inflated frequency of the low frequency stimuli, then it is to be expected that the difference in perceptual identification between high and low frequency words when two new word sets are used will reappear. It was decided therefore to run four more replications of Experiment Ia but a different set of high and low frequency words for each replication was employed.

<u>Method</u>

<u>Word Stimuli</u>

Four sets of four six letter disyllabic nouns were selected from among the words occurring more frequently than 40 times per million words as estimated by Thorndike & Lorge (1944). Four sets of four six letter two syllable pseudo-words were constructed. The pseudo-words were formed in the same way as described in Experiment Ia. Each word in each set was selected so that the initial letter of each word in a set was different. The word sets used in the four replications are shown in Table I.

Table I

TABLE I

Word Stimuli

Experiment Ib

WORD FREQUENCY	REPLICATION I	REPLICATION II	REPLICATION III	REPLICATION IV
HIGH	NOTION 43*	POWDER A	DESIGN A	ENGINE A
	PARENT A**	ORANGE A	FOREST AA	PRISON A
	HEAVEN AA	MEADOW 47	LAWYER 47	VOLUME A
	SAILOR A	SYSTEM AA	MAIDEN 45	TRAVEL AA
PSEUDO-WORDS	FABMIN	PAVNIL	FONLIN	GULVIC
	COLNAR	DEBLAM	MUFLIC	CUFNIG
	RABLAN	BOLVIN	TALNOM	PONSAB
	BESNIT	ROGPUL	WAVPIC	BELROC

* each value shown represents the frequency of occurrence of the word per million words

** no exact frequency value available for these words. Frequency = > 50 < 100 per million words

Experimental Design and Procedure

The experimental design and procedure utilized in these replications was identical with that of Experiment Ia. Each S was tested in four experimental sessions. A different set of high and low frequency words was employed for each replication.

Results

Figure 3 shows the relation between exposure duration and mean frequency of correct response for high and low frequency words for each experimental replication individually. In each replication, the difference

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Figure 3

---

in perceptual identification of high and low frequency words at each exposure duration is apparent.

Figure 4 plots the mean difference between frequency of correct response for high and low frequency stimuli across exposure duration as a function of replication. The results for all Ss combined

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Figure 4

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indicates no progressive decrease in the difference between high and low frequency word identification as a function of replications. Although there is variability of differences in perceptual identification of high and low frequency words among Ss and among replications, the difference is

FIGURE 3

Mean frequency of correct response as a function of exposure duration for high and low frequency words. The mean performance of five Ss for each of four replications is shown separately. The data points at exposure durations 1 to 5 represent the mean performance of five Ss. The data points at exposure duration 6 indicate the mean performance of three Ss.

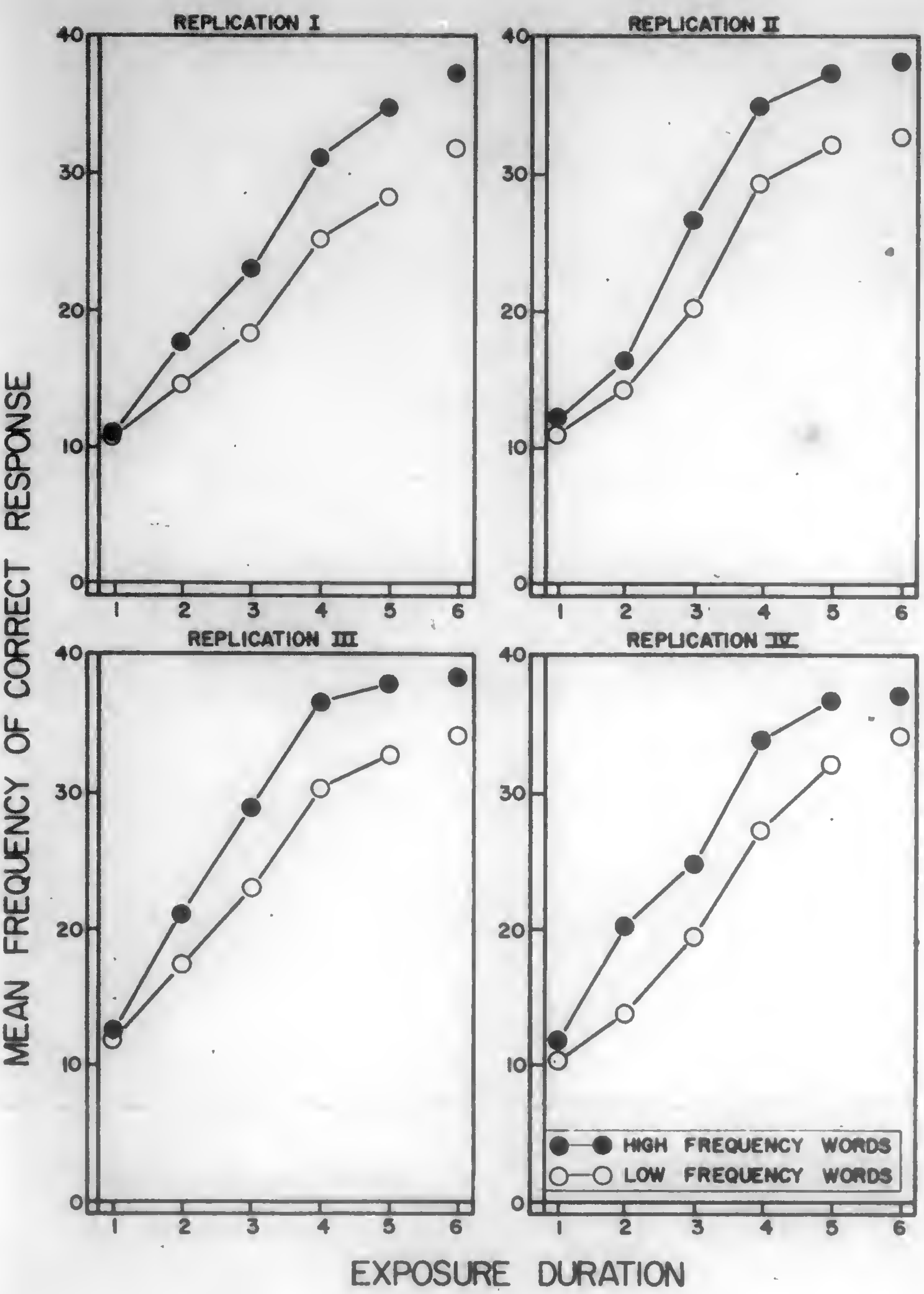
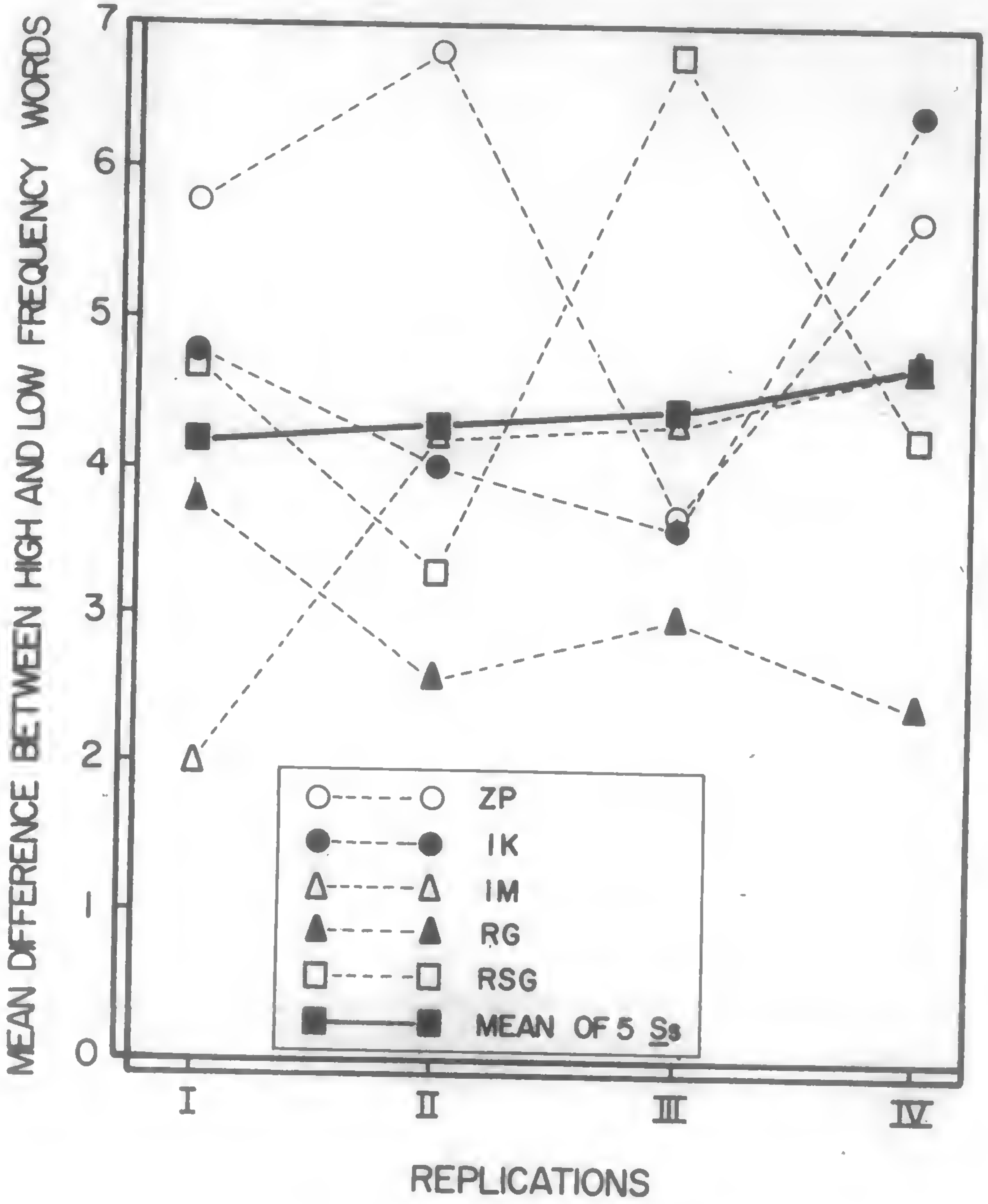

REPLICATION I
REPLICATION II
REPLICATION III
REPLICATION IV
MEAN FREQUENCY OF CORRECT RESPONSE
EXPOSURE DURATION
0
10
20
30
40
1
2
3
4
5
6
HIGH FREQUENCY WORDS
LOW FREQUENCY WORDS

FIGURE 4

Mean difference in frequency of correct response between high and low frequency words across all exposure durations as a function of replications. The dotted lines represent the relation obtained from individual Ss. The heavy line indicates the mean performance of five Ss.



MEAN DIFFERENCE BETWEEN HIGH AND LOW FREQUENCY WORDS
7
6
5
4
3
2
1
0
ZP
IK
IM
RG
RSG
MEAN OF 5 Ss
I
II
III
IV
REPLICATIONS

clearly indicated for each S and for each replication. The raw data are shown in Appendix III.

The results from the four replications have demonstrated the difference in perceptual identification between high and low frequency stimuli. The decrease in the difference across replications obtained in Experiment Ia must be attributable to the increase in frequency of the low frequency stimuli through repeated presentation. The value of the independent variable, frequency, appears to change rather than the effect of frequency upon perceptual identification of words or the use of strategies by the observer. The curves representing the influence of perceptual information varied by the manipulation of word frequency indicate that the perceptual information received and utilized from the stimulus increases more rapidly with exposure duration for high frequency words than for low frequency stimuli.

EXPERIMENT Ic

Since the effects of frequency upon perceptual identification of words has been clearly demonstrated for two extremes of the frequency continuum, it was decided to explore the nature of this relationship by employing more than two levels of the frequency variable. This experiment was designed to examine the effects of four levels of word frequency upon perceptual identification of words. Two replications of this study were carried out.

Method

Word Stimuli

Four six letter, two syllable words were selected at each of four levels of word frequency. Pseudo-words represented the lowest level of word frequency and were constructed in the same fashion as described in experiment Ia. Words occurring less than once per million represented the next frequency level. Words occurring four times per million represented the third level of frequency and words occurring at least 40 times per million were selected as the level of highest frequency. The Thorndike & Lorge Word Counts (1944) was the source from which the words were selected. The words in any particular word group each began with a different letter. A different set of words at the four levels of frequency was used in the two replications. The word sets are shown in Table 2.

Table 2

The Thorndike & Lorge (1944) frequency of occurrence value for each word is indicated.

TABLE 2

Word Stimuli

Experiment Ic

WORD FREQUENCY	REPLICATION I	REPLICATION II	MEAN
40 per million	CANDLE 43/million SECRET 41/million HUMOUR A* TREATY A*	DESERT A* MEMBER AA FIGURE AA BISHOP 40/million	
Mean Frequency			indeterminate
4 per million	KERNEL 4/million NOVICE 4/million PICKET 4/million STAMEN 4/million	BEACON 4/million GUITAR 4/million DESPOT 4/million CHERUB 4/million	
Mean Frequency			4
1 per million	CASEIN 13/18 million BELDAM 17/18 million GIMLET 15/18 million PEPSIN 15/18 million	BENZOL 13/18 million LITMUS 10/18 million PELVIS 13/18 million TORPOR 14/18 million	
Mean Frequency			.76
Pseudo-words	GOLRUM HUDNEG FOLBIS COVLUN	MURSOL WIRLIF KISTUL RISWOL	
Mean Frequency			0

* No exact frequency value available for these words. Frequency = > 50 < 100 per million.

Experimental Design

The experimental design of these replications was identical to that of experiments 1a and 1b. However, the number of responses required in each replication of this experiment was increased two-fold because four instead of two levels of frequency were used. Therefore each replication was carried out in two experimental sessions for each S since the total number of word presentations exceeded the number of presentations possible for a single hour session.

In the first session for each replication, 20 of the 40 stimuli for each of the four word groups were given to each S at each exposure duration level in her individual range. Order of presentation of word frequency groups and exposure duration was randomly determined for each individual S. In the second experimental session for a particular replication, the remaining 20 exposures of the words in each frequency group at each exposure duration were presented. The order of presentation of word frequency levels and exposure duration levels in the second session of each replication was the same as in the first session of each replication.

Results

It will be remembered that tachistoscopic word recognition threshold has been shown to bear an inverse relation to the logarithm of the frequency of word stimuli. In order to evaluate the role of word frequency in perceptual identification of words, the relation between

log word frequency and mean frequency of correct response across all exposure durations for the two replications combined is shown in Figure 5.

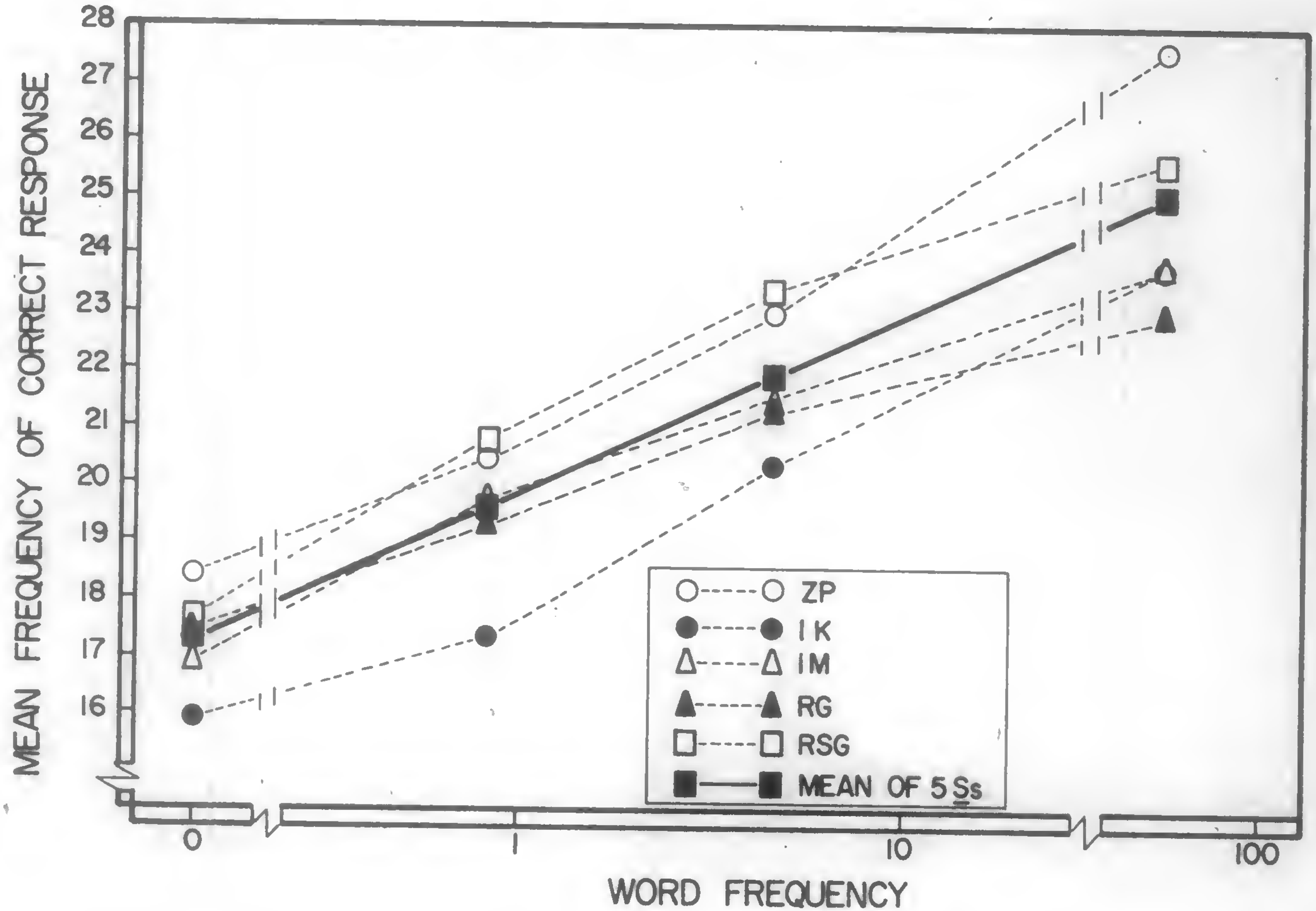
Figure 5

The log word frequency is plotted along the abcissa. The first set of data points on the left of the graph represent the mean frequency of correct response for the pseudo-words, i.e. zero frequency. Since log 0 = $-\infty$, for plotting purposes, the arbitrary value 0 was assigned to this expression. The second set of data points represents the mean number of correct responses for words occurring less than once per million. The mean frequency value for these words was .76 per million. The third set of data points represent mean number of correct identifications of words occurring with a frequency of four times per million. The final set of data points at the right are plotted as an estimate of the mean frequency of occurrence of words representing high frequency stimuli. The exact frequency of some of these words could not be calculated from the information available in Thorndike & Lorge (1944). The frequency value selected can only be regarded as an estimate of the mean frequency for the high frequency stimuli.

The heavy solid line on the graph represents the average number of correct responses for all exposure durations as a function of word frequency for all Ss combined. The relation obtained appears to be linear and indicates the direct relation between word frequency and

FIGURE 5

Mean frequency of correct response across exposure duration as a function of log word frequency. These data represent the mean performance of the two replications. The dotted lines indicate the mean performance of individual Ss. The heavy line represents the mean performance of five Ss.


MEAN FREQUENCY OF CORRECT RESPONSE
28
27
26
25
24
23
22
21
20
19
18
17
16
WORD FREQUENCY
0
1
10
100
ZP
IK
IM
RG
RSG
MEAN OF 5 Ss

perceptual identification of words. The dotted lines represent the data for individual Ss. It can be seen that the direct relation is shown in the performance of every S. The results are consistent for all Ss and attest to the reliability of the findings. It seems clear from these data that perceptual information available to Ss in tachistoscopic exposure of words depends upon word frequency.

In order to examine the joint effects of word frequency and exposure duration upon perceptual identification of words the empirical function relating exposure duration to mean frequency of correct response for four levels of word frequency was plotted. Figure 6 presents this relation for all subjects grouped across replications. To the extent that

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Figure 6

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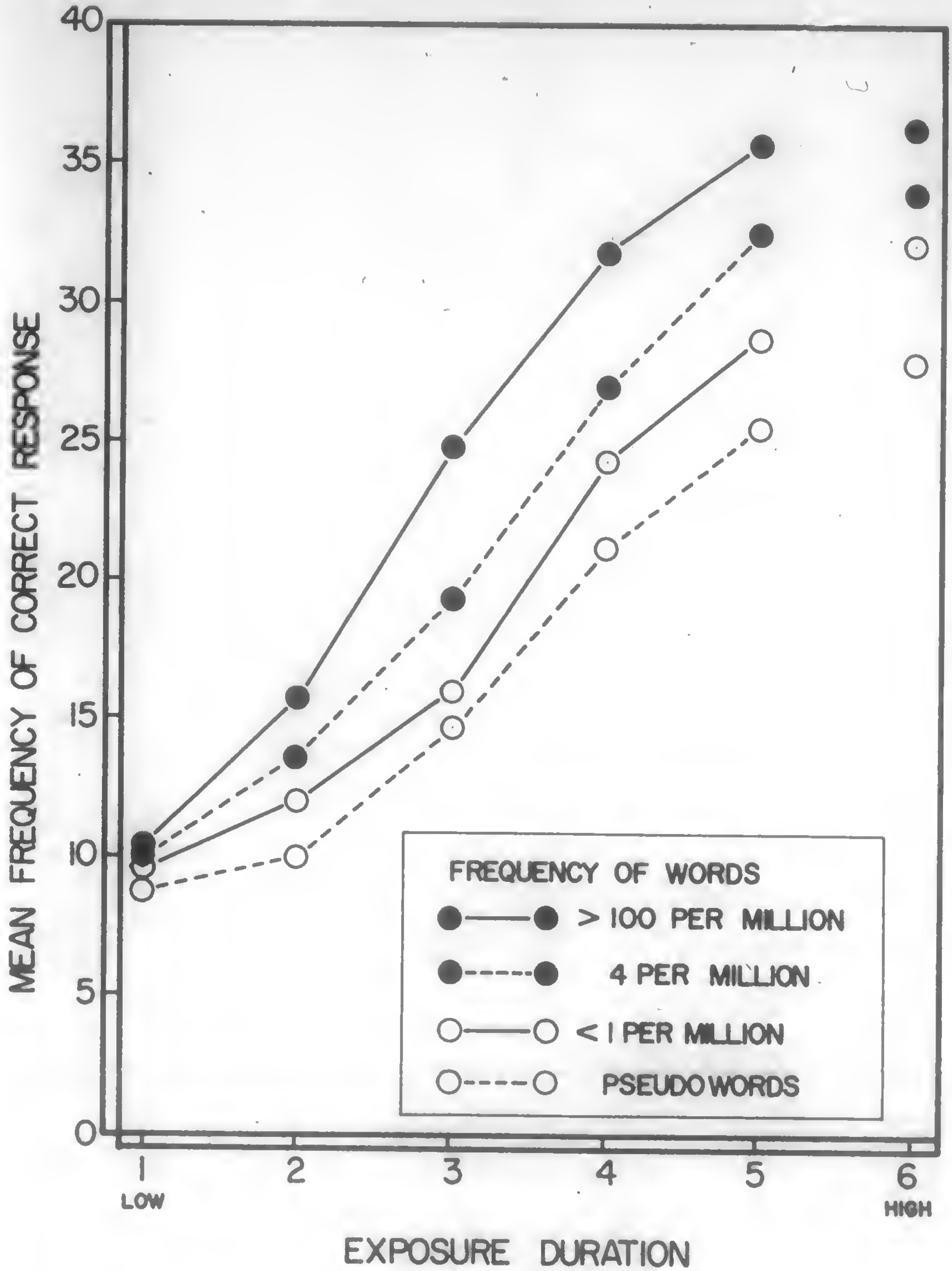
the four curves must necessarily begin at approximately chance level (ten correct responses) and to the extent that the slopes of these curves are different depending upon the level of word frequency, there seems to be an interaction between word frequency and exposure duration. Figure 7 shows the same data as shown in Figure 6 but for each replication separately.

Figure 7

It can be seen that the same interaction between word frequency and exposure duration is exhibited in each replication. An examination of the data from individual Ss shown in Appendix IV indicates the consistency between replications and among the Ss. Since the performance of Ss, i.e.

FIGURE 6

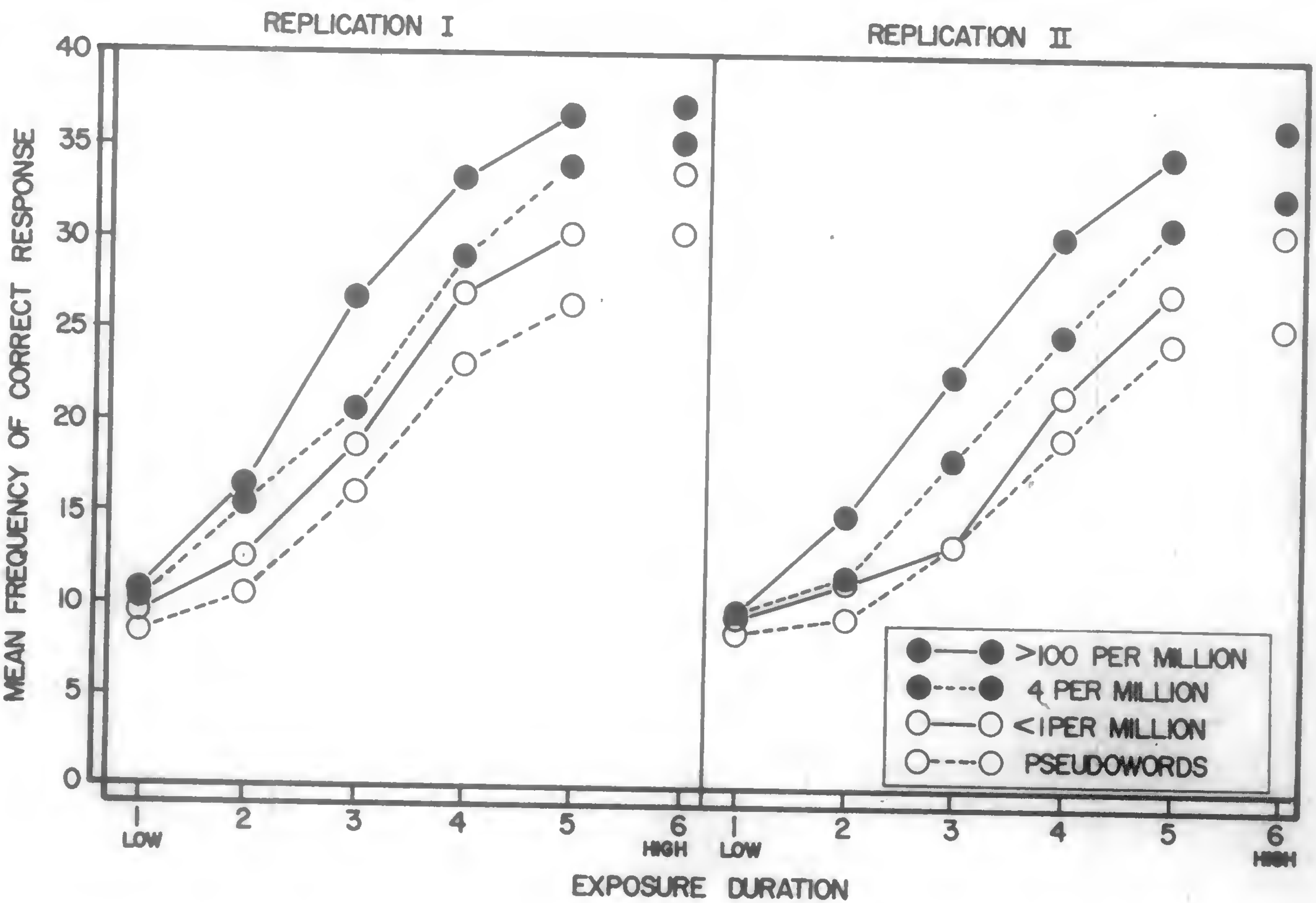
Mean frequency of correct response across two replications as a function of exposure duration for four levels of word frequency. The data points at exposure durations 1 to 5 represent the mean performance for five Ss. The data points at exposure duration 6 indicate the mean performance of three Ss.



MEAN FREQUENCY OF CORRECT RESPONSE
40
35
30
25
20
15
10
5
0
1
LOW
2
3
4
5
6
HIGH
EXPOSURE DURATION
FREQUENCY OF WORDS
> 100 PER MILLION
4 PER MILLION
< 1 PER MILLION
PSEUDOWORDS

FIGURE 7

Mean frequency of correct response as a function of exposure duration for four levels of word frequency. The mean performance of five Ss for each of the two replications is shown. The data points at exposure durations 1 to 5 represent the mean performance of five Ss. The data points at exposure duration 6 indicate the mean performance of three Ss.



REPLICATION I
REPLICATION II
MEAN FREQUENCY OF CORRECT RESPONSE
40
35
30
25
20
15
10
5
0
1 LOW
2
3
4
5
6 HIGH
EXPOSURE DURATION
>100 PER MILLION
4 PER MILLION
<1 PER MILLION
PSEUDOWORDS

the frequency of correct response has been identified with the amount of information that is available to observers in perceptual stimulation, then these data mean that perceptual information Ss received from tachistoscopic exposure of the stimulus and utilized increases more rapidly with exposure duration for high frequency words than for words of low frequency.

EXPERIMENT IIa

Experiment II was designed to study the effect of perceptual information available to Ss from tachistoscopic exposure of words upon word identification at different exposure durations. In this study, the major independent variable employed to vary perceptual information was word length. Two widely different values of word length, four and nine letters, were selected in order to determine whether manipulation of word length does in fact influence perceptual information. If perceptual information depends on word length, then differences in perceptual identification of words as a function of exposure duration should be demonstrated with the use of these extreme levels.

Method

Verbal Stimuli

The words were selected from among the nouns occurring four times per million in the English language (Thorndike & Lorge, 1944), since word length has been found to affect recognition threshold only for words of relatively infrequent occurrence in English (Newbigging, 1961). One set of words was composed of four four-letter, two syllable nouns. The short words were MICA, ORGY, BIAS, and EPIC. The second group contained four nine-letter two syllable nouns. These were CHAMPAGNE, HORSESHOE, SPORTSMAN and FRANCHISE.

Experimental Design

The design of this experiment was identical with the design employed in Experiments Ia and Ib. Two replications of the present study were carried out for each S.

Results

The number of correct responses at each exposure duration for each of the word stimuli within each length group was calculated. The total number of correct responses for each word set at each exposure duration was obtained for each S. Appendix V presents the data for individual Ss and the mean performance for Ss for both replications.

Figure 8 presents the grouped data for all Ss for both rep-

Figure 8

---

lications combined. Figure 9 shows the same data as shown in Figure 8, but for the two replications separately. On both these graphs, the

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Figure 9

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ordinal numbers along the abcissa represent the levels of exposure duration from low to high for all Ss. The mean frequency of correct response is shown on the ordinate. The parameter is word length. It can be seen that for each replication and therefore for the two replications combined the mean frequency of correct response for the four letter words is greater than the frequency of correct response for nine letter words at every exposure duration. Further, the difference in performance appears to remain constant across all exposure durations. An examination of the data from individual Ss indicates that for every S at every exposure duration, in each replication frequency of correct response is greater for four letter words

FIGURE 8

Mean frequency of correct response as a function of exposure duration for two levels of word length. The graph represents the mean performance of five Ss across two replications. The data points at exposure durations 1 to 5 indicate the mean performance of five Ss. The data points at exposure duration 6 shows the mean performance of three Ss.

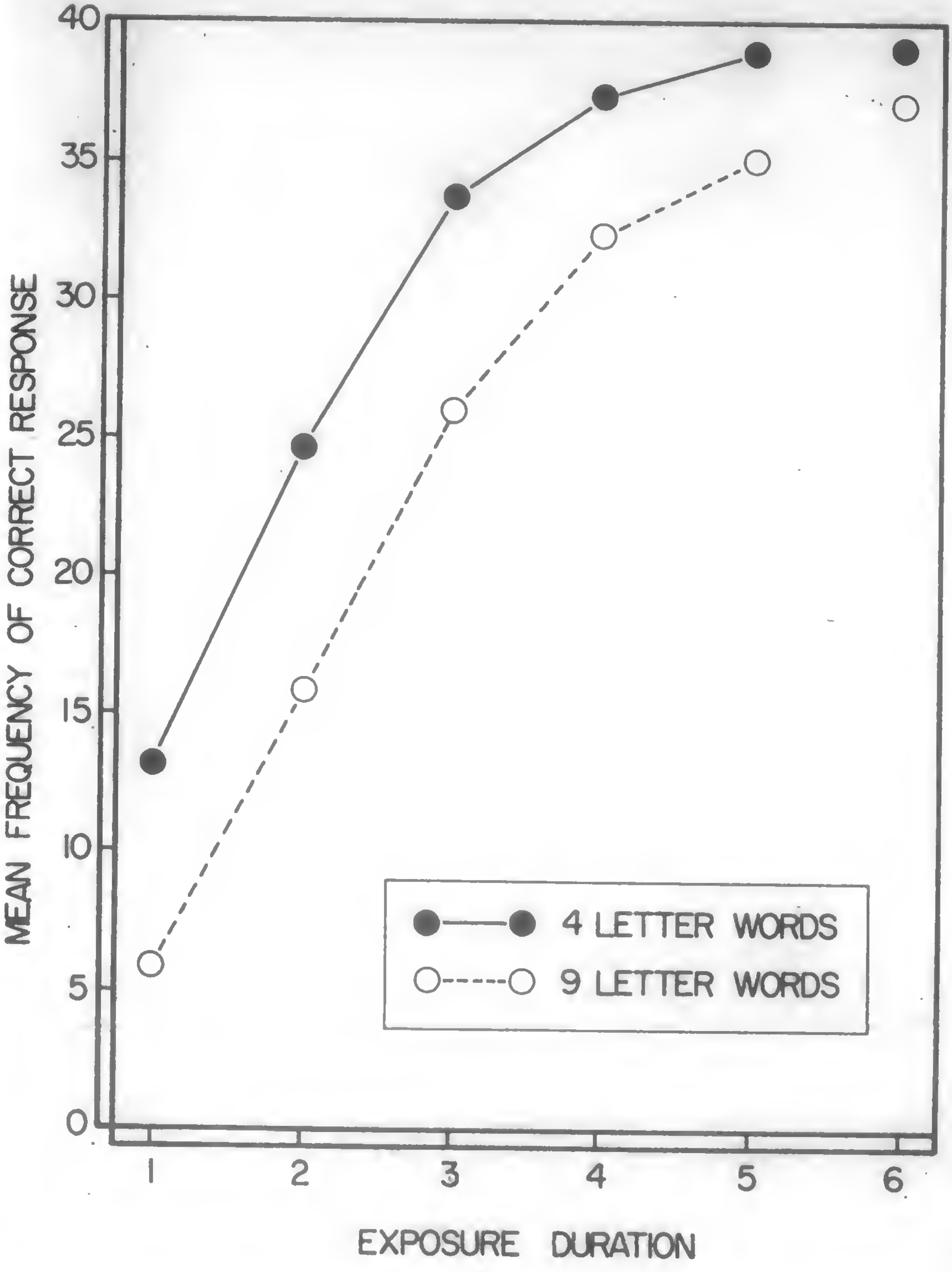
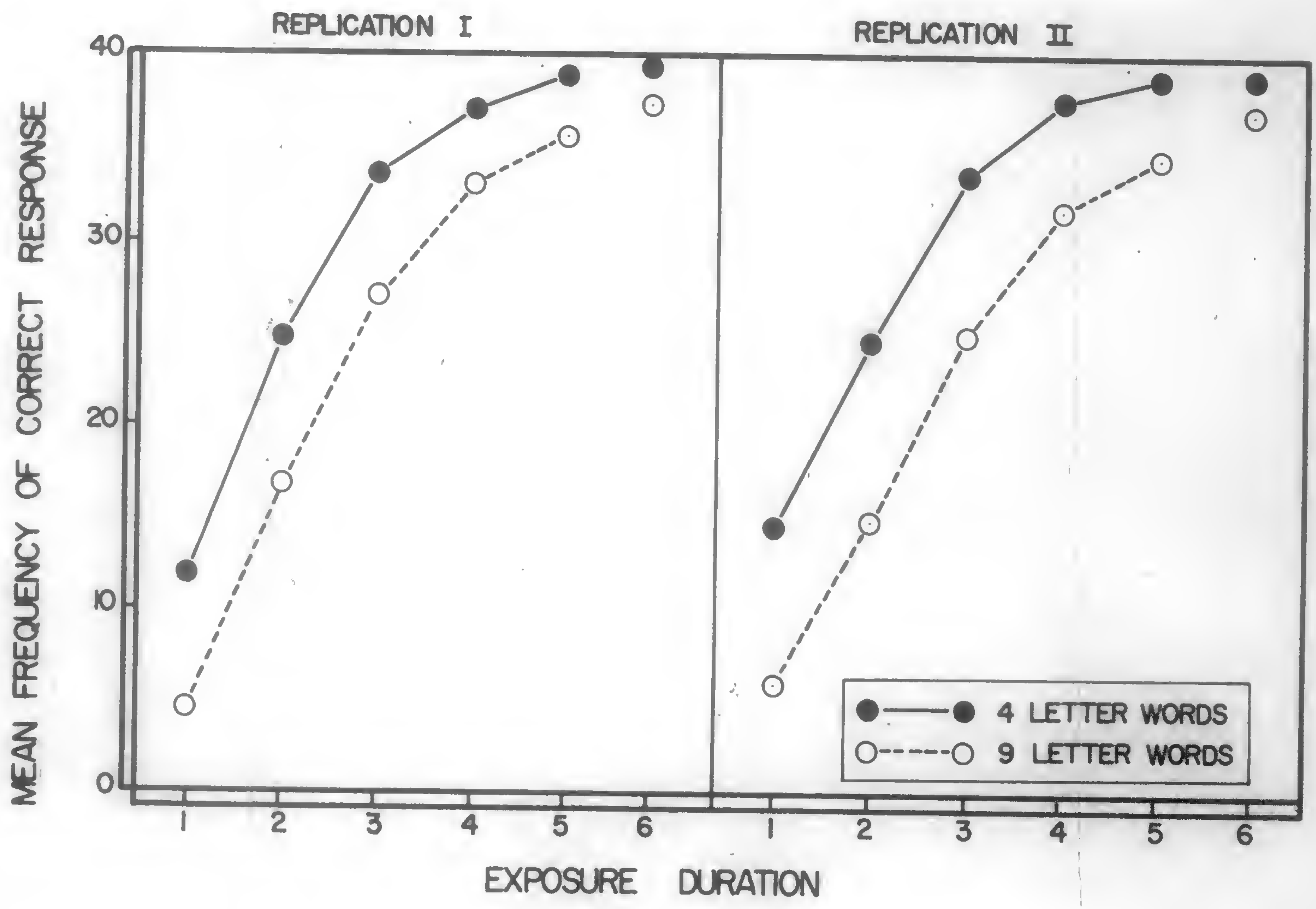

MEAN FREQUENCY OF CORRECT RESPONSE
40
35
30
25
20
15
10
5
0
1
2
3
4
5
6
EXPOSURE DURATION
4 LETTER WORDS
9 LETTER WORDS

FIGURE 9

Mean frequency of correct response as a function of exposure duration for two levels of word length. The mean performance of five Ss for each of two replications is shown. The data points at exposure durations 1 to 5 represent the mean performance of five Ss. The data points at exposure duration 6 indicate the mean performance of three Ss.


REPLICATION I
REPLICATION II
MEAN FREQUENCY OF CORRECT RESPONSE
0
10
20
30
40
1
2
3
4
5
6
EXPOSURE DURATION
4 LETTER WORDS
9 LETTER WORDS

than for nine letter words. This difference remains relatively constant for individual Ss both within a particular replication and between replications. The variability of differences among Ss can be seen to be small. The interpretation that word length affects perceptual information and hence identification of words seems to be merited.

han for nine letter words. This difference remains relatively constant or individual Ss both within a particular replication and between replications. The variability of differences among Ss can be seen to be mall. The interpretation that word length affects perceptual information nd hence identification of words seems to be merited.

EXPERIMENT IIb

Since the effects of word length upon perceptual identification of words has been demonstrated for two widely different levels of length, the nature of this relation was examined by employing four levels of word length. This experiment was designed to investigate the effects of four levels of length upon perceptual identification of words as a function of exposure duration. Two replications of this experiment were carried out.

Method

Word Stimuli

Four two syllable nouns occurring four times per million words in the English language were selected at each of four levels of word length; three letters, five letters, seven letters and nine letters. Each word in each word set began with a different letter. A different set of words at each of the four levels of word length was used in each of the two replications. The word sets are shown in Table 3.

Table 3

Experimental Design

The experimental design of this study was the same as the one used in Experiment Ic.

Results

The relation between word length and mean frequency of correct

TABLE 3

Word Stimuli

Experiment 2b

LENGTH	REPLICATION I	REPLICATION II
3 LETTERS	BUN EEL JIG ROE	KEG CUR POD IMP
5 LETTERS	GABLE JUROR WAFER TONIC	MISER PIVOT TITAN ENVOY
7 LETTERS	BUNTING CULPRIT MOURNER PIGMENT	GARBAGE CARTOON BLEMISH PRELATE
9 LETTERS	CARTRIDGE PHOSPHATE DEATHRATE STARLIGHT	SWIFTNESS BLACKMAIL CLEARNESS WHITEWASH

response across all exposure durations for the two replications combined and for all Ss examined in order to determine the role of word length upon perceptual identification of words. Figure 10 indicates this re-

Figure 10

lationship. Word length is plotted along the abcissa. The ordinate indicates the obtained frequency of correct response. The heavy line on the graph represents the function of all Ss. It can be seen that frequency of correct response decreases as word length increases. The dotted lines represent the relationship obtained from individual Ss. In every instance, the inverse relation is found. The difference among subjects can be seen to be small. In view of the consistency of the data, these results indicate that perceptual identification of words depends upon word length.

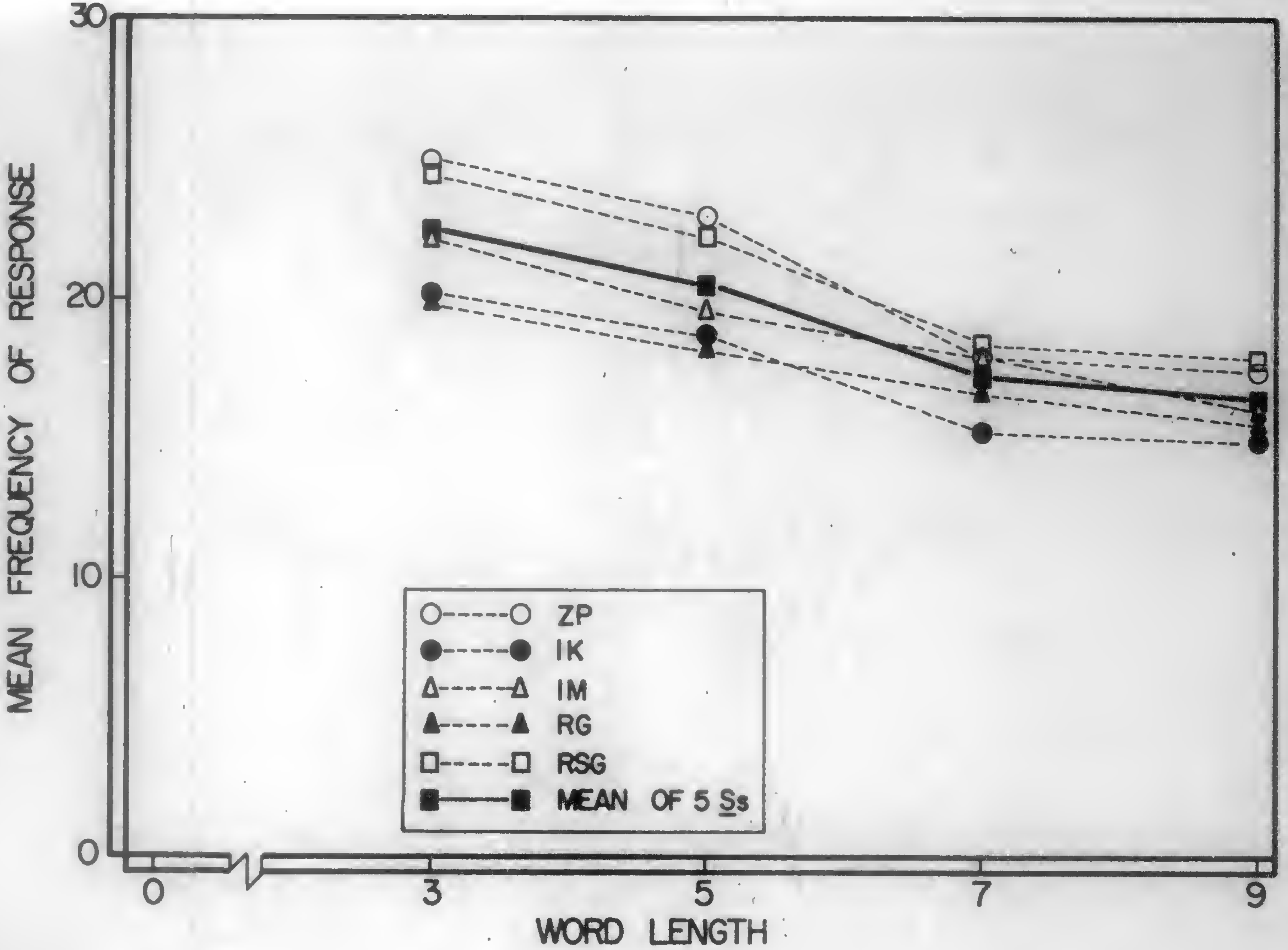
In order to determine the nature of the combined effects of word length and exposure duration upon word identification, the function relating exposure duration to mean frequency of correct response for four levels of word length was plotted. Figure 11 shows this relation for all

Figure 11

Ss across both replications. It appears that word length and exposure duration interact in their effect upon perceptual identification of words. The curves necessarily begin at approximately chance level and diverge depending upon the level of word length considered. The slopes of the

FIGURE 10

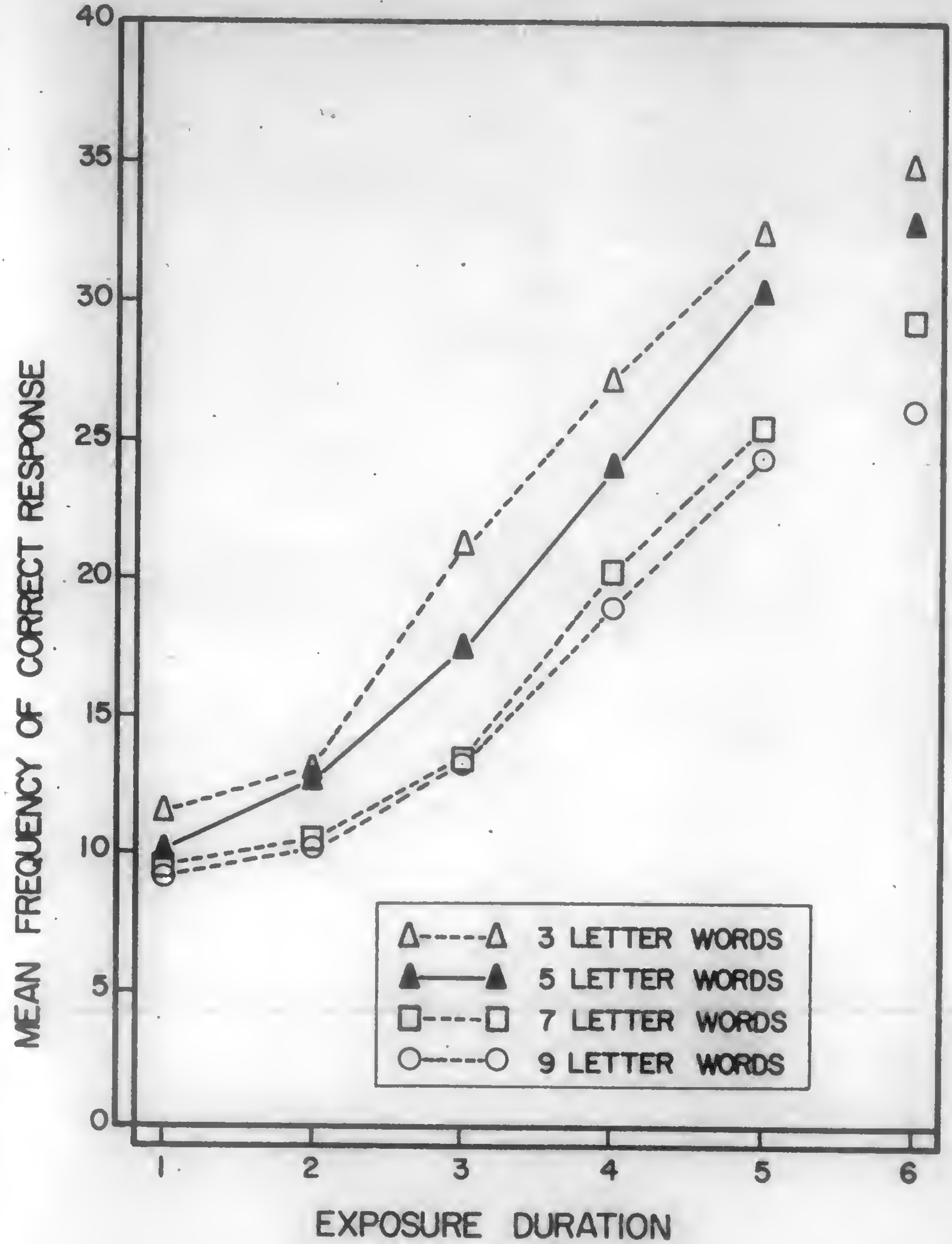
Mean frequency of correct response across exposure duration as a function of word length. The dotted lines indicate the function for individual Ss across two replications. The heavy line demonstrates the function for five Ss across replications.



MEAN FREQUENCY OF RESPONSE
30
20
10
0
0
3
5
7
9
WORD LENGTH
ZP
IK
IM
RG
RSG
MEAN OF 5 Ss

FIGURE 11

Mean frequency of correct response as a function of exposure duration for four lengths of words. The graph represents the mean performance of five Ss across two replications. The data points at exposure durations 1 to 5 represent the mean performance of five Ss. The data points at exposure duration 6 indicate the mean performance of three Ss.


MEAN FREQUENCY OF CORRECT RESPONSE
0
5
10
15
20
25
30
35
40
1
2
3
4
5
6
EXPOSURE DURATION
3 LETTER WORDS
5 LETTER WORDS
7 LETTER WORDS
9 LETTER WORDS

curves increase in steepness in an inverse relation to the word length at any particular exposure duration. Figure 12 is a plot of the same data, but the results of each replication are shown separately. The

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Figure 12

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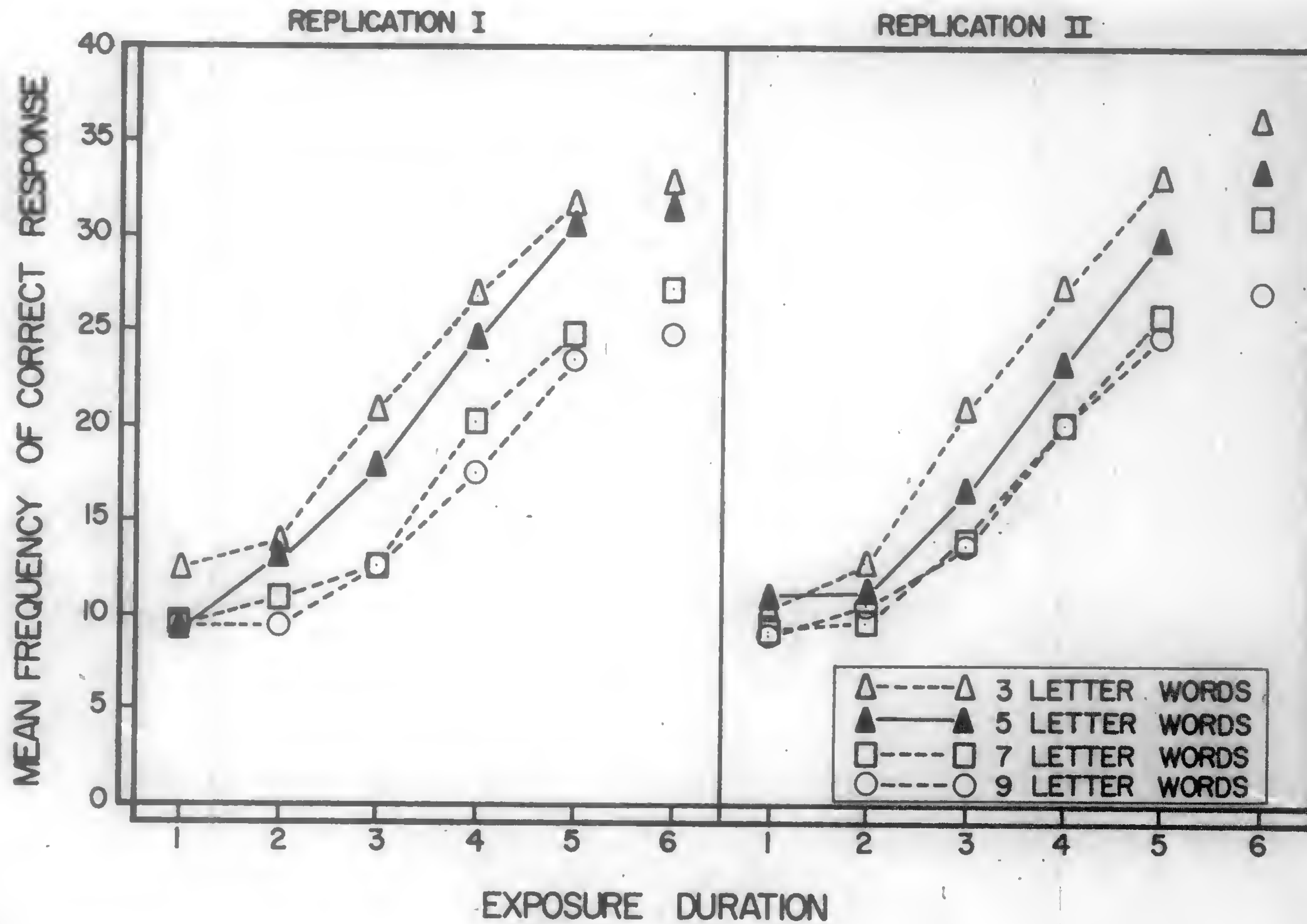
relation between exposure duration and frequency of correct response as a function of word length is consistent from replication to replication. Perceptual identification of words can be seen to be a function of word length and exposure duration. Since frequency of correct response has been regarded as indicating a reception and utilization of perceptual information, then these data may be interpreted to mean that the reception and utilization of information increases more rapidly with exposure duration for short words than for long words.

FIGURE 12

Mean frequency of correct response as a function of exposure duration for four levels of word length. The graph shows the mean performance of five Ss for each of two replications. The data points at exposure durations 1 to 5 indicate the mean performance for five Ss. The data points at exposure duration 6 show the mean performance for three Ss.


REPLICATION I
REPLICATION II
MEAN FREQUENCY OF CORRECT RESPONSE
0
5
10
15
20
25
30
35
40
1
2
3
4
5
6
3 LETTER WORDS
5 LETTER WORDS
7 LETTER WORDS
9 LETTER WORDS
EXPOSURE DURATION

EXPERIMENT III

Experiment III was designed to investigate the effects of verbal context upon perceptual identification of words as a function of exposure duration. Two different lengths of verbal context, eight word and zero word contexts were selected. These values of context were selected in order to determine whether manipulation of the length of context does in fact vary perceptual information. If perceptual information depends upon the length of context within which the information appears, then the difference in perceptual identification of words seen in context and without should be demonstrated. This study was replicated three times for each subject.

Method

Word Stimuli and Contexts

Four words used by Gold (1960) were selected as tachistoscopic stimuli to be presented in the presence and absence of verbal context. The words were equated for frequence (four per million, Thorndike & Lorge, 1944) length (nine letters), number of syllables (three) and grammatical class (nouns). The four words were PERFORMER, RASPBERRY, DESERTION and BOULEVARD.

The contexts were nine word English sentences in which the word stimuli were final members. In other words, the contexts were sequences of eight related words relevant to and preceding the ninth word, the tachistoscopic word stimulus. For each of the four word stimuli, one of four contexts was relevant. The contexts were: THE ACTRESS RECEIVED PRAISE FOR BEING AN OUTSTANDING (performer); THE ESCAPED SOLDIER WAS CAPTURED AND

COURTMARTIALLED FOR (desertion); SHE LIKES RED FRUIT JAMS OF STRAWBERRY AND (raspberry); and MANY COLOURFUL FLOWERS AND STATELY ELMS LINED THE (boulevard).

Each of the four contexts was typed with an IBM electric typewriter in upper case letters on a large white card. Two inches below the context in the centre of the field was the fixation point in the place of which the word stimulus appeared. The context was exposed to the S in the pre-exposure field of the tachistoscope. When the S was to identify words in the absence of contexts, the pre-exposure field was simply a blank field marked only by the usual fixation point.

Experimental Design

Ss identified the same four words in the presence and absence of eight word contexts at each exposure duration in their range. Each of the four words was presented ten times in random order at each exposure duration in the presence of and without context. Hence each S made forty responses in the presence of context and forty responses without context at each level of duration. Under the context condition S was required to read the contexts aloud after every five word exposures in order to maintain attention to the contexts. The order of presentation of the context conditions and the particular contexts seen was randomly determined. As in the previous experiments, order of presentation of exposure durations was random and words were exposed in blocks of twenty. Six random orders of the forty stimuli to be presented at each exposure duration for each of the two context conditions were oonstructed to control for the effects of memory.

This experiment was replicated three times for each individual S using the same materials, order of presentation of oonditions and contexts

and exposure duration.

Results

Since the same four words were shown at every exposure duration in the presence of one of the four contexts, the particular context shown at a particular exposure duration was relevant to only one of the four words, i.e. to the ten presentations of the relevant word. The remaining thirty word presentations were irrelevant to the context seen in the pre-exposure field. Therefore the data obtained under the context conditions must be partitioned into these two components; the proportion of correct responses of the word relevant to the context and the proportion of correct responses to the remaining three words that were irrelevant to the context. If context serves to vary perceptual information and hence correct word identification, then it is expected that performance in the presence of relevant context would be superior to performance in the presence of irrelevant context.

Figure 13 presents the grouped data for all subjects across

Figure 13

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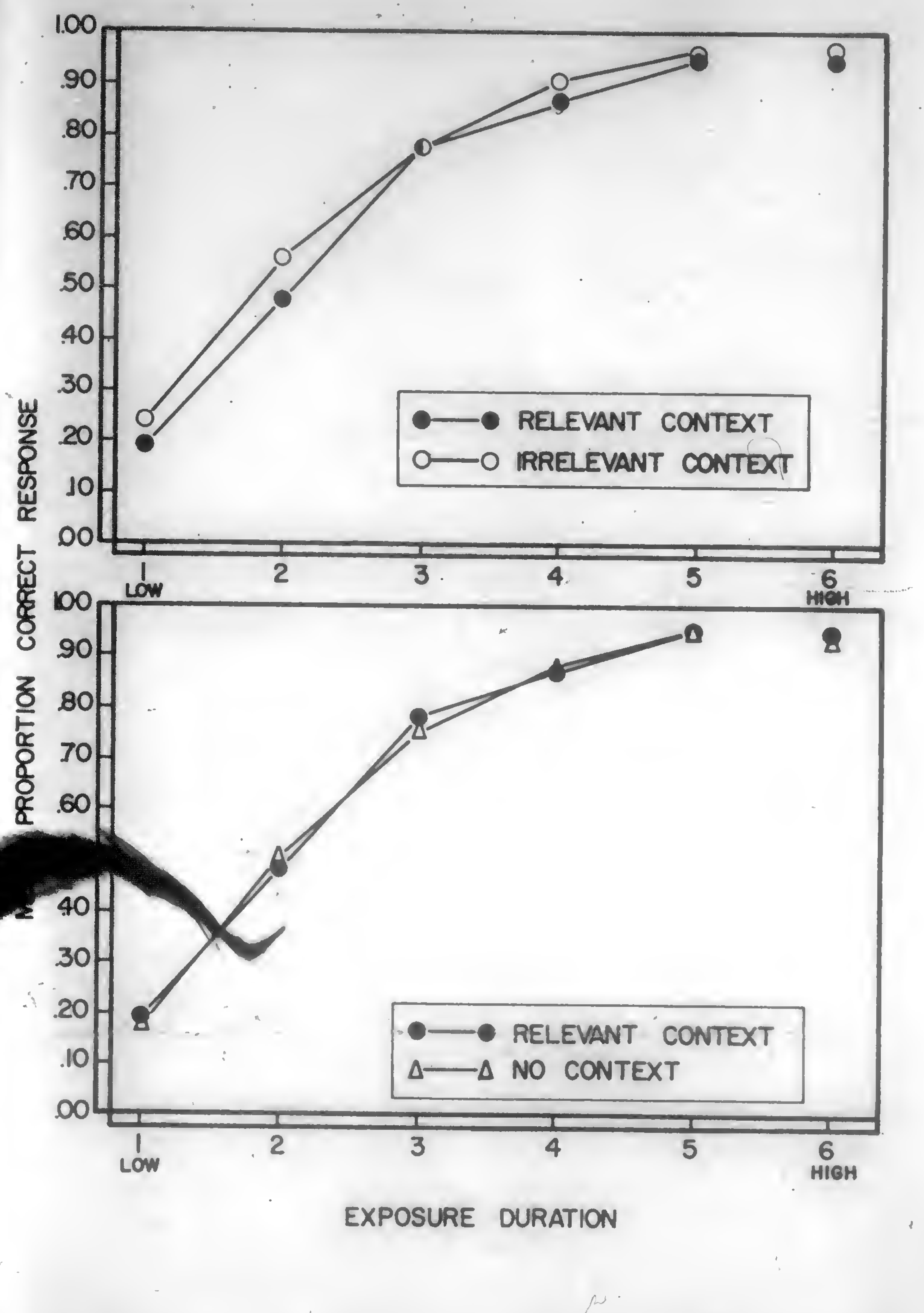
the three replications. The upper graph presents the relation between exposure duration and mean proportion of correct responses for words seen in relevant contexts and for words seen in irrelevant contexts. Although it appears that perceptual identification of words is slightly superior for words seen in irrelevant contexts, analysis of variance indicates no

FIGURE 13

Mean proportion of correct response as a function of exposure duration for words seen in context and without context. The upper graph shows the relation between exposure duration and performance for words seen in relevant and irrelevant contexts. The lower graph indicates the relation between exposure duration and performance for words seen in relevant context and without context. The graphs show the mean performance for five Ss across three replications. The data points at exposure durations 1 to 5 show the mean performance for five Ss. The data points at exposure duration 6 indicate the mean performance for two Ss.


PROPORTION CORRECT RESPONSE
1.00
.90
.80
.70
.60
.50
.40
.30
.20
.10
.00
RELEVANT CONTEXT
IRRELEVANT CONTEXT
1
LOW
2
3
4
5
6
HIGH
RELEVANT CONTEXT
NO CONTEXT
EXPOSURE DURATION

significant interaction between relevant and irrelevant contexts and exposure duration ($F < 1$, df 5,39). No significant difference in performance under irrelevant and relevant context conditions ($F = 2.25$, df 1) was found. Exposure duration is significant beyond the .01 level ($F = 152.18$, df 5). The analysis of variance is summarized in Appendix VIII.

The effects of context may be shown in another way. Perceptual identification of words may be facilitated by relevant context when compared to performance with the same word in the absence of context. Therefore, the proportion of correct responses as a function of exposure duration for words seen in relevant context can be compared to performance with the same words seen without context.

The lower graph in Figure 13 indicates the functions relating exposure duration to mean proportion of correct response as a funotion of relevant and no context conditions. Again, it appears that words seen under relevant context conditions are not identified more often correctly than words seen without context.

Figure 14 presents the same data as shown in Figure 13, but for

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Figure 14

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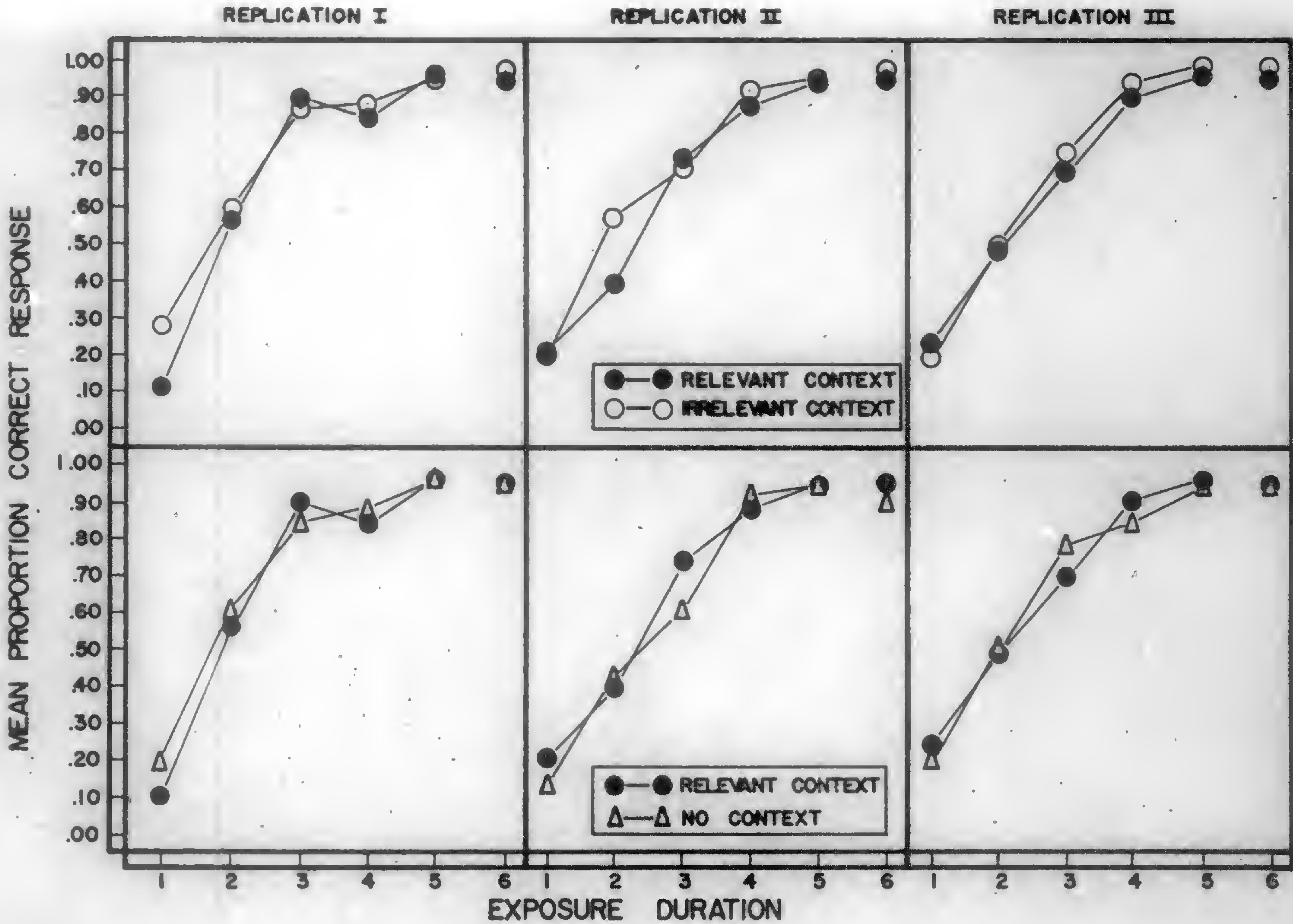
each of the three replications separately. It can be seen that the relation between exposure duration and mean proportion of correct responses for words seen in irrelevant and relevant contexts is consistent from replication to replication. The lower half of the graph also indicates the consistency of the data among replications for words seen under relevant context and without context.

FIGURE 14

Mean proportion of correct response as a function of exposure duration for words seen in context and without context. The mean performance of five Ss is shown for each of three replications. The upper graphs indicate the relation between exposure duration and performance for words seen in relevant and irrelevant context. The lower graphs show the relation between exposure duration and performance for words seen in relevant context and without context. The data points at exposure durations 1 to 5 show the mean performance of five Ss. The data points at exposure duration 6 indicate the mean performance of two Ss.



REPLICATION I
REPLICATION II
REPLICATION III
MEAN PROPORTION CORRECT RESPONSE
1.00
.90
.80
.70
.60
.50
.40
.30
.20
.10
.00
RELEVANT CONTEXT
IRRELEVANT CONTEXT
RELEVANT CONTEXT
NO CONTEXT
1 2 3 4 5 6
EXPOSURE DURATION

The data for individual Ss is presented in Appendix VII. It can be seen that the results for each S are consistent across replications. Further, the variability among Ss is small. The results from the three replications of this experiment demonstrate that perceptual identification of words is not influenced by the presence of context. It appears that manipulation of context conditions does not vary perceptual information available to Ss during tachistoscopic presentation of words.

DISCUSSION

Recognition thresholds for words obtained under the AML can be assumed to reflect the effects of several different sources of information that are available to the observer in the tachistoscopic situation. In fact, it has been shown that subjects can "identify" words even in the absence of perceptual information (Goldiamond & Hawkins, 1958). Since various sources of information are confounded in the recognition task, it is extremely difficult to evaluate the effects upon perceptual process of variables under consideration. The forced-choice method however, permits the separation of the role of perceptual information from other sources of information which may affect word identification. Whenever performance exceeds chance level under the forced-choice method, the results can be attributed solely to the utilization of perceptual information transmitted by the stimulus. The purpose of this thesis was to separate and evaluate the effects of exposure duration, word frequency, word length and pre-exposure verbal context upon the utilization of perceptual information. The forced-choice method was employed in order to allow such a separation and assessment.

Exposure duration was varied in all experiments reported. The dependence of correct word identification upon exposure duration was unequivocally demonstrated in all experiments. The frequency of correct response to perceptual stimulation was shown to increase directly as a function of exposure duration. Increasing exposure duration serves to make increasingly more information available to the subject with a consequent improvement in performance.

The main interest in the present experiments lay in the examination of the effects of several variables that had previously been shown to affect recognition thresholds upon the utilization of perceptual information under conditions of forced-choice. In the first series of experiments, empirical functions relating frequency of correct response to exposure duration as a function of word frequency were determined. The results indicated that ease of perceptual identification is determined by both word frequency and exposure duration. Frequency of correct response was found to be greater for high frequency stimuli than for low frequency stimuli at all levels of exposure duration and increased with exposure duration for words of all frequencies. These results suggest that utilization of perceptual information varies directly with exposure duration as has been shown previously (Miller, Bruner & Postman, 1954). Further, if word frequency serves to vary the amount of information transmitted by the stimuli, then the more frequently a word has occurred in the past, the greater the probability of its occurrence in the future and hence the smaller the amount of information transmitted by its occurrence. The smaller the amount of information conveyed by a stimulus word, the smaller the amount of stimulus energy (exposure duration) necessary for correct word identification. Hence it is reasonable to expect that frequent words will be recognized correctly more often than infrequent words at any particular exposure duration level. The results of the present studies are interpretable in these terms. Since frequency of correct word identification increases as word frequency increases as a function of exposure duration, the utilization of perceptual information defined in these terms can thus be seen to vary inversely with the amount of information

contained in the stimuli.

The second series of studies investigated the relation between word length and ease of perceptual identification of words as a function of exposure duration. Correct identification of words was shown again to increase with exposure duration. At any given level of exposure duration however, short words were identified correctly more often than long words. If information contained in a word is specified in terms of the number of sub-units such as letters or other fragments, the results are consistent with those of the first series of experiments. The smaller the number of sub-units in a word the smaller the amount of information contained in a word and hence the more easily it is identified.

The third experiment examined the effects of the presence and absence of pre-exposure verbal context within which stimulus words are seen upon ease of perceptual identification of these words. While it was again shown that word identification increased as a direct function of exposure duration, no difference in ease of perceptual identification occurred under the two conditions of context. Earlier experiments (Cuddy, 1961; Gold, 1960) have shown that recognition threshold is an inverse function of length of relevant context. The present experiment was concerned with the question of whether the effect of context upon recognition threshold was mediated by perceptual facilitation or past experience, i.e., response bias. If relevant context in some way facilitates perceptual identification of words, then words seen in the presence of relevant context, under conditions of forced choice, should have been identified correctly more often than words seen in irrelevant context or in the

absence of context. Since the findings of the present experiment indicate no difference in perceptual identification of words seen with and without context, the results of Cuddy, 1961 and Gold, 1960 appear to be due to response biases which provide information about the word stimulus rather than affecting the perceptual information conveyed by the stimulus word itself. It can be concluded that perceptual information is not dependent upon the presence of absence of pre-exposure verbal context.

The results of all experiments were well documented. The variability in performance among observers was small in each experiment. Since each experiment was replicated several times for each observer and the findings were consistent among replications as well as among subjects, it seems reasonable to assume that the results obtained are reliable and valid, at least for trained observers. It is reasonable to expect that with naive subjects, the effects would appear to be less systematic due to the well-known influence of practice upon perceptual activity. The problem regarding the utilization of perceptual information varied in terms of variables previously shown to affect word recognition was clarified empirically. Perceptual identification of words was consistently shown to depend upon exposure duration, word frequency and word length, but not verbal context.

The findings that frequency and length, but not context, affect utilization of perceptual information from the tachistoscopically

presented stimulus makes good sense. Frequency and length are properties of the stimulus word. These properties can be assumed to be related to the amount of information in the stimulus, although the relations involved cannot be readily quantified. Since frequency and length can be assumed to be related to stimulus information, it is reasonable to argue that these variables affect the availability and utilization of this information in the tachistoscopic identification task. Context however, does not vary the properties of the stimulus. It simply serves to restrict the number of alternatives that subjects consider as possible responses. In the experiments with context using the AML, such restriction of alternatives has a beneficial effect upon threshold values by providing a certain amount of information about the nature of the stimulus word, and therefore necessitating less information from the stimulus word as such. Under the forced-choice method, the effectiveness of context is curtailed, since the method itself involves the restriction of response alternatives. In the present experiment, subjects had only four responses from which to choose and the context did not provide any additional information.

The findings of the present experiments are important for two main reasons. First, they demonstrate the availability of techniques suited to the purpose of the study of perceptual process and the variables affecting its operation. The forced-choice method seems eminently suited to the analysis of perceptual identification of words as a function of many variables. Secondly, the results provide grounds for questioning several

assumptions that have been made about perceptual process on the basis of recognition threshold data yielded by the AML.

It will be remembered that threshold data obtained by the AML suggested that word frequency (Howes & Solomon, 1951; King-Ellison & Jenkins, 1954; Postman & Schneider, 1951; Solomon & Postman, 1952), word length (eg. McGinnies, Comer & Lacey, 1952; Newbigging, 1961) and pre-exposure verbal context (eg. Cofer & Shepp, 1957; Cuddy, 1961; Gold, 1960) are all relevant variables affecting perceptual identification of words. It has often been assumed that since these variables bear some relation to recognition threshold, they necessarily are related to the utilization of perceptual information. With reference to the role of word frequency in word recognition, Goldiamond & Hawkins (1958) have challenged the notion that word frequency affects ease of perceptual identification. They found the well-known inverse relation between word frequency and recognition threshold even in the absence of perceptual stimulation. On the basis of their data, they concluded that

> "...frequency does not affect perception, but does affect response bias...(p. 462).

Goldstein & Ratleff (1961) using a forced-choice method found no frequency effects upon perceptual identification of words under narrow experimental conditions. They also tended to support the conclusion of Goldiamond & Hawkins (1958) that only response is affected by word frequency. While a response interpretation appears sufficient to explain such data, it does not necessarily exclude the possibility that word frequency affects perceptual process as well. The experiments reported here regarding the role

of word frequency in perceptual identification clearly indicate that word frequency affects the utilization of perceptual information. Since Goldiamond & Hawkins' data (1958) are equally clear regarding the effect of word frequency upon word emission, it seems reasonable to assume that word frequency in recognition threshold has a dual effect. It seems obvious that the question regarding the locus of the effects of word frequency cannot be answered by either a response or perceptual interpretation alone.

The assumption regarding the perceptual effects of word length has been justified by the results of the present experiments. Word length has been shown to affect the utilization of perceptual information and hence the perceptual identification of words. Rosenzweig & Postman (1958) have offered one explanation to account for the finding that long words have higher recognition thresholds than short words.

> "...the longer the word, the greater the chance that part of it will not be perceived...It should also be noted that length is penalized by the fixed time of tachistoscopic presentation,... In tachistoscopic presentation, words of different length are compared at the same durations of exposure, and there is not time to shift the fixation of the eyes as in ordinary reading. The greater the number of units to be discriminated during a single exposure the more rapidly must each be discriminated." (p. 267)

Therefore the rate of discrimination must increase as word length increases in order for identification to be complete. This reasoning appears to be logical for the experimental situation where the subject does not know in advance the word stimulus to be identified. However, in the present research with the forced-choice technique, subjects may not need to see the entire word in order to make correct identification of the stimulus word

since the word stimuli are known. If the argument advanced earlier in this discussion regarding the differential amount of information contained in words of varying length is tenable, then an explanation in information theory terms of the effects of length upon the utilization of perceptual information in the forced-choice situation is more applicable. Whatever the nature of the explanation to account for the differential effects of word length, the studies reported here demonstrate clearly that word length affects perceptual identification of words.

Verbal context has also been assumed to affect the ease of perceptual identification of words simply because a relation between verbal context conditions and recognition threshold was found to exist (eg. Cuddy, 1961; Gold, 1960). However, the present investigation offers contradictory evidence. Context does not appear to affect the utilization of perceptual information. Since the effects of context upon perception are excluded, it follows that previous results must have reflected the operation of other processes, presumably response bias.

Since the studies reported here refute some earlier assumptions regarding the role of some variables in word recognition, a clear demonstration of the need for the separation of sources of variance affecting word recognition has been provided. Further, the methods for such an analysis have been shown to be available. It is in the experimental clarification of these problems that the main contribution of the present research lies. The present studies also point out the need for the consideration of perceptual events in relation to other processes. The fact that threshold data reflect the operation of processes other than

perception indicate the complexity of what have been regarded as perceptual phenomena.

The results of this research present a challenge to perceptual theory for explanation. In view of the present state of perceptual theory, little would be accomplished by the attempt to fit data such as those obtained in the present experiments into any one particular theoretical point of view. Several theoretical notions are available which could possibly account for some if not all of the present data (eg. Bruner, 1951, Ch. 5; Gibson, 1951; Hebb, 1949, Chs. 4 & 5; Postman, 1951, Ch. 10). For example, the conceptual framework of information theory provides one set of concepts which can be utilized. In fact, much of the present discussion has utilized the descriptive terms of information theory without any attempt at specific quantification. Such notions are useful in that they provide a cohesive set of terms with which to specify empirical operations. It is the author's opinion however, that at the present stage of development of perceptual theory, the best mode of attack on the problem of perceptual behaviour is the empirical examination of perceptual phenomena and the slow synthesis of these findings. We must first be certain that we are investigating those functions we purport to examine. Then it is necessary to determine the variables and the nature of their effect upon the operation of perceptual process. Perhaps in this way, we can begin to develop a comprehensive perceptual theory.

SUMMARY

Although word frequency, word length and context have been shown to affect word recognition threshold, there has been much debate regarding the extent to which these variables affect the utilization of perceptual information received by the observer from the tachistoscopic stimulus. The major difficulty in assessing the role of perceptual information in word recognition has been shown to lie in the use of the AML for threshold determination. With the use of this method, the contribution of perceptual information to word recognition threshold cannot be separated from the role of other sources of information.

The problem with which this thesis was concerned was an evaluation of the role of perceptual information in tachistoscopic identification of verbal stimuli. Perceptual information was varied in terms of three quantitative characteristics of verbal stimuli; word frequency, word length and the presence or absence of context. Three experiments were carried out in which the frequency of correct response as a function of exposure duration was determined for words varying in frequency of occurrence in language usage, length and appearance on the presence or absence of context. A forced-choice method was used in order to permit a separate analysis of the influence of perceptual information upon tachistoscopic identification of words.

The first experiment examined the effects of word frequency upon perceptual identification of words as a function of exposure duration. It was found that perceptual identification of words increased as word

frequency increased as a direct function of exposure duration. These data were interpreted to mean that the utilization of perceptual information by the subject in the tachistoscopic task depends upon word frequency and exposure duration.

The second experiment investigated the role of word length upon perceptual identification of words as a function of exposure duration. Perceptual identification of words was seen to increase as word length decreased for all levels of exposure duration. The utilization of perceptual information was shown to depend upon word length.

The third experiment evaluated the effects of verbal context upon perceptual identification of words as a function of exposure duration. It was found that performance in the presence of context does not differ from performance without context. It was concluded that context does not affect the utilization of perceptual information and hence does not affect perceptual identification of words.

These findings provided grounds for questioning the earlier assumptions about the role of word frequency, word length and verbal context in word recognition. The studies demonstrated the necessity for separating and analysing the various sources of information available to the observer in the tachistoscopic recognition task. It was pointed out that the main contribution of this research lies in the empirical demonstration of the effects of perceptual information varied in three ways upon tachistoscopic word identification and in the application of the forced-choice technique to the study of perceptual process.

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APPENDIX I

Exposure duration ranges for individual subjects for each experiment. The values shown are millisecond units. Exposure duration was varied in units of 10 milliseconds.

APPENDIX I

Exposure Duration Ranges

	EXPERIMENT					
SUBJECTS	Ia	Ib	Ic	2a	2b	3
RG	40-80 msec.	40-80 msec.	40-80 msec.	40-80 msec.	40-80 msec.	40-80 msec.
RSG	60-110 msec.	60-110 msec.	60-110 msec.	60-110 msec.	60-110 msec.	60-110 msec.
IK	60-100 msec.	60-100 msec.	60-100 msec.	60-100 msec.	60-100 msec.	60-100 msec.
IM	60-110 msec.	60-110 msec.	60-110 msec.	70-120 msec.	60-110 msec.	70-120 msec.
ZP	60-110 msec.	60-110 msec.	60-110 msec.	60-110 msec.	60-110 msec.	60-100 msec.

APPENDIX II

Experiment Ia

Frequency of correct response for high and low frequency words at all levels of exposure duration. Data from individual subjects for each of three replications are shown.

H = high frequency words
L = low frequency words
D = H - L

APPENDIX II

Experiment Ia

REPLICATION I

Ss	Word Frequency	1	2	3	4	5	6	$\bar{x}$
				EXPOSURE DURATIONS				
ZP	H	21	25	35	35	38	39	
	L	4	16	29	30	36	38	
	D	17	9	6	5	2	1	6.7
IK	H	6	12	35	38	40		
	L	0	7	18	35	40		
	D	6	5	17	3	0		6.2
IM	H	13	20	31	33	37	38	
	L	10	14	23	28	31	32	
	D	3	6	8	5	6	6	5.7
RG	H	18	23	26	32	40		
	L	10	12	22	28	37		
	D	8	11	4	4	3		6.0
RSG	H	10	34	34	37	37	40	
	L	6	11	26	29	32	36	
	D	4	23	8	8	5	4	8.7
$\bar{x}$	H	13.6	22.8	32.2	35.0	38.4	39.0	
	L	6.0	12.0	23.6	30.0	35.2	35.2	
	D	7.6	10.8	8.6	5.0	3.2	3.7	6.7

APPENDIX II (CONTINUED)

Experiment 1a

REPLICATION II

Ss	Word Frequency	EXPOSURE DURATIONS 1	2	3	4	5	6	$\bar{x}$
ZP	H	18	26	35	38	38	40	
	L	13	24	27	33	37	38	
	D	5	2	8	5	1	2	3.8
IK	H	14	20	30	33	39		
	L	11	16	21	30	38		
	D	3	4	9	3	1		4.0
IM	H	14	20	28	34	36	38	
	L	10	17	24	30	32	34	
	D	4	3	4	4	4	4	3.8
RG	H	15	19	24	32	37		
	L	11	16	21	30	36		
	D	4	3	3	2	1		2.6
RSG	H	19	27	35	36	39	40	
	L	13	25	29	35	37	37	
	D	6	2	6	1	2	3	3.3
$\bar{x}$	H	16.0	22.4	30.4	34.6	37.8	39.3	
	L	11.6	19.6	24.4	31.6	36.0	36.3	
	D	4.4	2.8	6.0	3.0	1.8	3.0	3.5

APPENDIX II (CONTINUED)

Experiment Ia

REPLICATION III

EXPOSURE DURATIONS

Ss	Word Frequency	1	2	3	4	5	6	$\bar{x}$
ZP	H	14	19	24	35	36	39	
	L	12	20	26	34	36	38	
	D	2	-1	-2	1	0	1	.2
IK	H	10	18	34	36	40		
	L	12	19	32	38	40		
	D	-2	-1	2	-2	0		-.6
IM	H	12	17	25	26	30	33	
	L	12	16	25	25	31	34	
	D	0	1	0	1	-1	-1	0
RG	H	11	20	24	35	39		
	L	13	19	24	38	38		
	D	-2	1	0	-3	1		-.6
RSG	H	16	26	30	36	39	40	
	L	13	26	31	37	40	40	
	D	3	0	-1	-1	-1	0	0
$\bar{x}$	H	12.6	20.0	27.4	33.6	36.8	37.3	
	L	12.4	20.0	27.6	34.4	37.0	37.3	
	D	0.2	0.0	-0.2	-0.8	-0.2	0.0	-.2

APPENDIX III

Experiment Ib

Frequency of correct response for high and low frequency words at all levels of exposure duration. Data for individual subjects for each of the four replications are shown.

H = high frequency words
L = low frequency words
D = H - L

APPENDIX III

Experiment Ib

REPLICATION I

Ss	Word Frequency	1	2	3	4	5	6	$\bar{x}$
		EXPOSURE DURATIONS						
ZP	H	9	16	22	32	35	40	
	L	12	14	15	24	24	30	
	D	-3	2	7	8	11	10	5.8
IK	H	10	20	24	34	38		
	L	9	15	20	26	32		
	D	1	5	4	8	6		4.8
IM	H	12	16	20	23	28	32	
	L	12	16	17	20	24	30	
	D	0	0	3	3	4	2	2.0
RG	H	8	17	21	32	37		
	L	8	12	18	27	31		
	D	0	5	3	5	6		3.8
RSG	H	17	20	29	35	37	40	
	L	14	17	22	30	31	36	
	D	3	3	7	5	6	4	4.7
$\bar{x}$	H	11.2	17.8	23.2	31.2	35.0	37.3	
	L	11.0	14.8	18.4	25.4	28.4	32.0	
	D	0.2	3.0	4.8	5.8	6.6	5.3	4.2

APPENDIX III (CONTINUED)

Experiment Ib

REPLICATION II

Ss	Word Frequency	EXPOSURE DURATIONS 1	2	3	4	5	6	$\bar{x}$
ZP	H	13	16	32	38	38	40	
	L	10	14	23	28	28	33	
	D	3	2	9	10	10	7	6.8
IK	H	10	16	26	34	38		
	L	9	14	20	27	34		
	D	1	2	6	7	4		4.0
IM	H	15	16	19	28	31	35	
	L	10	13	15	26	27	28	
	D	5	3	4	2	4	7	4.2
RG	H	10	14	22	36	40		
	L	12	13	16	32	36		
	D	-2	1	6	4	4		2.6
RSG	H	13	20	34	39	40	40	
	L	14	18	27	34	36	37	
	D	-1	2	7	5	4	3	3.3
$\bar{x}$	H	12.2	16.4	26.6	35.0	37.4	38.3	
	L	11.0	14.4	20.2	29.4	32.2	32.7	
	D	1.2	2.0	6.4	5.6	5.2	5.6	4.3

APPENDIX III (CONTINUED)

Experiment Ib

REPLICATION III

Ss	Word Frequency	1	2	3	4	5	6	$\bar{x}$
		EXPOSURE DURATIONS						
ZP	H	14	20	29	39	39	40	
	L	12	19	26	32	33	37	
	D	2	1	3	7	6	3	3.7
IK	H	12	30	33	40	40		
	L	12	24	30	35	36		
	D	0	6	3	5	4		3.6
IM	H	14	18	24	30	33	35	
	L	11	14	19	26	27	31	
	D	3	4	5	4	6	4	4.3
RG	H	10	14	26	36	39		
	L	12	13	18	30	37		
	D	-2	1	8	6	2		3.0
RSG	H	14	24	33	39	39	40	
	L	13	17	22	29	32	35	
	D	1	7	11	10	7	5	6.8
$\bar{x}$	H	12.8	21.2	29.0	36.8	38.0	38.3	
	L	12.0	17.4	23.0	30.4	33.0	34.3	
	D	.8	3.8	6.0	6.4	5.0	4.0	4.4

APPENDIX III (CONTINUED)

Experiment Ib

REPLICATION IV

EXPOSURE DURATIONS

Ss	Word Frequency	1	2	3	4	5	6	$\bar{x}$
ZP	H	12	27	28	37	38	39	
	L	13	17	19	29	32	37	
	D	-1	10	9	8	6	2	5.7
IK	H	13	19	30	37	39		
	L	8	10	20	31	37		
	D	5	9	10	6	2		6.4
IM	H	8	15	18	28	32	33	
	L	8	14	14	17	24	29	
	D	0	1	4	11	8	4	4.7
RG	H	9	16	18	32	36		
	L	10	12	16	28	33		
	D	-1	4	2	4	3		2.4
RSG	H	18	25	31	38	40	40	
	L	14	17	30	33	35	38	
	D	4	8	1	5	5	2	4.2
$\bar{x}$	H	12.0	20.4	25.0	34.4	37.0	37.3	
	L	10.6	14.0	19.8	27.6	32.2	34.7	
	D	1.4	6.4	5.2	6.8	4.8	2.6	4.7

APPENDIX IV

Experiment Ic

Frequency of correct response for words of four different frequencies at all levels of exposure duration. Data from individual subjects for each of two replications are shown. Also shown are the mean values across both replications.

a = > 40 per million
b = 4 per million
c = < 1 per million
d = pseudo-words

APPENDIX IV

Experiment Ic

REPLICATION I

EXPOSURE DURATIONS

Ss	Word Frequency	1	2	3	4	5	6	$\bar{x}$
ZP	a	9	18	30	38	38	39	28.7
	b	11	17	22	31	34	39	25.7
	c	10	10	23	29	31	36	23.2
	d	7	10	18	26	30	34	20.8
IK	a	13	14	27	34	37		25.0
	b	8	12	16	29	37		20.4
	c	8	13	17	25	29		18.4
	d	9	8	13	24	25		15.8
IM	a	10	13	20	27	33	34	22.8
	b	9	17	17	25	29	32	21.5
	c	10	12	18	23	26	31	20.0
	d	9	11	14	17	22	27	16.7
RG	a	8	14	28	34	38		24.4
	b	11	13	23	31	36		22.8
	c	9	10	16	29	33		19.4
	d	10	10	18	29	30		19.4
RSG	a	14	23	29	34	37	39	29.3
	b	12	18	25	29	34	35	25.5
	c	10	17	19	29	32	34	23.5
	d	8	14	17	19	25	30	18.8
$\bar{x}$	a	10.8	16.4	26.8	33.4	36.6	37.3	26.1
	b	10.2	15.4	20.6	29.0	34.0	35.3	23.3
	c	9.4	12.4	18.6	27.0	30.2	33.7	21.0
	d	8.6	10.6	16.0	23.0	26.4	30.3	18.4

APPENDIX IV (CONTINUED)

Experiment Ic

REPLICATION II

Ss	Word Frequency	EXPOSURE DURATIONS 1	2	3	4	5	6	$\bar{x}$
ZP	a	10	11	25	29	35	38	24.7
	b	9	8	20	20	30	34	20.2
	c	10	10	12	20	27	30	18.2
	d	9	8	12	17	25	25	16.0
IK	a	8	16	22	28	39		22.6
	b	10	14	17	26	34		20.2
	c	10	10	12	21	28		16.2
	d	8	11	14	21	26		16.0
IM	a	13	15	23	29	33	36	24.8
	b	10	13	19	24	29	33	21.3
	c	10	13	16	21	25	31	19.3
	d	10	12	14	19	22	25	17.0
RG	a	11	16	22	34	35		23.6
	b	8	12	16	30	33		19.8
	c	12	13	14	26	31		19.2
	d	7	9	11	23	28		15.6
RSG	a	7	17	22	31	32	35	24.0
	b	12	12	18	25	29	31	21.2
	c	6	12	13	20	26	31	18.0
	d	10	7	16	17	22	26	16.3
$\bar{x}$	a	9.8	15.0	22.8	30.2	34.8	36.3	24.0
	b	9.8	11.8	18.0	25.0	31.0	32.7	20.6
	c	9.6	11.6	13.4	21.6	27.4	30.7	18.2
	d	8.8	9.4	13.4	19.4	24.6	25.3	16.2

APPENDIX IV (CONTINUED)

Experiment Ic

MEANS FOR REPLICATIONS I & II

Ss	Word Frequency	1	2	3	4	5	6	$\bar{x}$
		EXPOSURE DURATIONS						
ZP	a	9.5	14.5	27.5	33.5	36.5	38.5	26.7
	b	10.0	12.5	21.0	25.5	32.0	36.5	23.0
	c	10.0	10.0	17.5	24.5	29.0	33.0	20.7
	d	8.0	9.0	15.0	21.5	27.5	29.5	18.4
IK	a	10.5	15.0	24.5	31.0	38.0		23.8
	b	9.0	13.0	16.5	27.5	35.5		20.3
	c	9.0	11.5	14.5	23.0	28.5		17.3
	d	8.5	9.5	13.5	22.5	25.5		15.9
IM	a	11.5	14.0	21.5	28.0	33.0	35.0	23.8
	b	9.5	15.0	18.0	24.5	29.0	32.5	21.4
	c	10.0	12.5	17.0	22.0	25.5	31.0	19.7
	d	9.5	11.5	14.0	18.0	22.0	26.0	16.9
RG	a	9.5	15.0	25.0	34.0	36.5		24.0
	b	9.5	12.5	19.5	30.5	34.5		21.3
	c	10.5	11.5	15.0	27.5	32.0		19.3
	d	8.5	9.5	14.5	26.0	29.0		17.5
RSG	a	10.5	20.0	25.5	32.5	34.5	37.0	26.7
	b	12.0	15.0	21.5	27.0	31.5	33.0	23.4
	c	8.0	14.5	16.0	24.5	29.0	32.5	20.8
	d	9.0	10.5	16.5	18.0	23.5	28.0	17.6
$\bar{x}$	a	10.3	15.7	24.8	31.8	35.7	36.3	25.1
	b	10.0	13.6	19.3	27.0	32.5	34.0	21.9
	c	9.5	12.0	16.0	24.3	28.8	32.2	19.6
	d	8.7	10.0	14.7	21.2	25.5	27.8	17.3

APPENDIX V

Experiment 2a

Frequency of correct response for short and long words at all levels of exposure duration. Data from individual subjects for each of two replications are shown. Also shown are the mean values across both replications.

APPENDIX V

Experiment 2a

REPLICATION I

EXPOSURE DURATIONS

Ss	Length	1	2	3	4	5	6
ZP	4	9	19	33	38	40	40
	9	6	15	27	36	36	40
IK	4	10	27	37	38	40	
	9	4	16	28	35	39	
IM	4	15	21	28	31	36	38
	9	5	12	16	24	28	32
RG	4	10	24	31	39	40	
	9	2	12	29	33	38	
RSG	4	15	33	39	39	39	40
	9	6	29	35	37	37	40
$\bar{x}$	4	11.8	24.8	33.6	37.0	39.0	39.3
	9	4.6	16.8	27.0	33.0	35.6	37.3

APPENDIX V (CONTINUED)

Experiment 2a

REPLICATION II

		EXPOSURE DURATION					
Ss	Length	1	2	3	4	5	6
ZP	4	9	16	29	38	40	40
	9	5	11	22	30	35	40
IK	4	10	30	38	40	40	
	9	6	13	29	36	39	
IM	4	17	23	30	32	35	37
	9	8	14	16	22	27	32
RG	4	14	20	34	39	40	
	9	5	12	26	35	36	
RSG	4	22	34	38	40	40	40
	9	6	24	32	36	36	39
$\bar{x}$	4	14.4	24.6	33.8	37.8	39.0	39.0
	9	6.0	14.8	25.0	31.8	34.6	37.0

APPENDIX V (CONTINUED)

Experiment 2a

MEANS FOR REPLICATIONS I & II

Ss	Length	EXPOSURE DURATIONS 1	2	3	4	5	6
ZP	4	9.0	17.5	31.0	38.0	40.0	40.0
	9	5.5	13.0	24.5	33.0	35.5	40.0
IK	4	10.0	28.5	37.5	39.0	40.0	
	9	5.0	14.5	28.5	35.5	39.0	
IM	4	16.0	22.0	29.0	31.5	35.5	37.5
	9	6.5	13.0	16.0	23.0	27.5	32.0
RG	4	12.0	22.0	32.5	39.0	40.0	
	9	3.5	12.0	27.5	34.0	37.0	
RSG	4	18.0	33.5	38.5	39.5	39.5	40.0
	9	6.0	26.5	33.5	36.5	36.5	39.5
$\bar{x}$	4	13.1	24.7	33.7	37.4	39.0	39.2
	9	5.3	15.8	26.0	32.4	35.1	37.2

APPENDIX VI

Experiment 2b

Frequency of correct response for words of four different lengths at all levels of exposure duration. Data from individual subjects for each of two replications are shown. Also shown are the mean values across both replications.

APPENDIX VI

Experiment 2b

REPLICATION I

		EXPOSURE DURATIONS						
Ss	Length	1	2	3	4	5	6	$\bar{x}$
ZP	3	13	16	23	29	31	34	24.3
	5	9	16	23	27	32	35	23.7
	7	10	12	13	22	23	27	17.8
	9	10	11	14	20	23	24	17.0
IK	3	10	11	20	26	31		19.6
	5	10	13	20	25	33		20.2
	7	9	11	11	20	25		15.2
	9	10	7	13	16	24		14.0
IM	3	16	11	20	26	31	31	22.5
	5	12	14	15	23	28	29	20.2
	7	9	10	14	19	23	28	17.2
	9	9	11	13	15	20	24	15.3
RG	3	11	12	18	26	32		19.8
	5	8	11	14	21	30		16.8
	7	10	11	12	21	28		16.4
	9	10	9	11	18	26		14.8
RSG	3	12	15	24	28	34	34	24.5
	5	8	16	17	27	31	31	21.7
	7	10	11	14	19	26	27	17.8
	9	7	10	13	19	25	27	16.8
$\bar{x}$	3	12.4	13.0	21.0	27.0	31.8	33.0	22.3
	5	9.4	14.0	17.8	24.6	30.8	31.7	20.6
	7	9.6	11.0	12.8	20.2	25.0	27.3	17.0
	9	9.2	9.6	12.8	17.6	23.6	25.0	15.7

APPENDIX VI (CONTINUED)

Experiment 2b

REPLICATION II

EXPOSURE DURATIONS

Ss	Length	1	2	3	4	5	6	$\bar{x}$
ZP	3	10	15	22	30	36	38	25.2
	5	12	9	19	23	32	36	21.8
	7	7	10	12	22	25	32	18.0
	9	8	9	12	20	27	30	17.7
IK	3	11	13	21	27	32		20.8
	5	9	11	16	23	27		17.2
	7	7	11	15	20	23		15.2
	9	10	10	16	20	22		15.6
IM	3	10	12	20	23	31	34	21.7
	5	11	8	17	20	27	30	18.8
	7	11	9	15	18	27	30	18.3
	9	5	13	15	20	23	23	16.5
RG	3	9	13	17	29	33		20.2
	5	12	13	15	26	32		19.6
	7	11	9	13	23	28		16.8
	9	10	11	14	20	27		16.4
RSG	3	12	11	25	27	34	37	24.3
	5	11	16	17	25	32	35	22.7
	7	10	10	15	18	27	32	18.7
	9	12	11	12	21	26	29	18.5
$\bar{x}$	3	10.4	12.8	21.0	27.2	33.2	36.3	22.6
	5	11.0	11.4	16.8	23.4	30.0	33.7	20.1
	7	9.2	9.8	14.0	20.2	26.0	31.3	17.5
	9	9.0	10.8	13.8	20.2	25.0	27.3	17.0

APPENDIX VI (CONTINUED)

Experiment 2b

MEANS FOR REPLICATIONS I & II

Ss	Length	EXPOSURE DURATIONS 1	2	3	4	5	6	$\bar{x}$
ZP	3	11.5	15.5	22.5	29.5	33.5	36.0	24.8
	5	10.5	12.5	21.0	25.0	32.0	35.5	22.8
	7	8.5	11.0	12.5	22.0	24.0	29.5	17.9
	9	9.0	10.0	13.0	20.0	25.0	27.0	17.3
IK	3	10.5	12.0	20.5	26.5	31.5		20.2
	5	9.5	12.0	18.0	24.0	30.0		18.7
	7	8.0	11.0	13.0	20.0	24.0		15.2
	9	10.0	8.5	14.5	18.0	23.0		14.8
IM	3	13.0	11.5	20.0	24.5	31.0	32.5	22.1
	5	11.5	11.0	16.0	21.5	27.5	29.5	19.5
	7	10.0	9.5	14.5	18.5	25.0	29.0	17.8
	9	7.0	12.0	14.0	17.5	21.5	23.5	15.9
RG	3	10.0	12.5	17.5	27.5	32.5		20.0
	5	10.0	12.0	14.5	23.5	31.0		18.2
	7	10.5	10.0	12.5	22.0	28.0		16.6
	9	10.0	10.0	12.5	19.0	26.5		15.6
RSG	3	12.0	13.0	24.5	27.5	34.0	35.5	24.4
	5	9.5	16.0	17.0	26.0	31.5	33.0	22.2
	7	10.0	10.5	14.5	18.5	26.5	29.5	18.3
	9	9.5	10.5	12.5	20.0	25.5	28.0	17.7
$\bar{x}$	3	11.4	12.9	21.0	27.1	32.5	34.7	22.4
	5	10.2	12.7	17.3	24.0	30.4	32.7	20.4
	7	9.4	10.4	13.4	20.2	25.5	29.3	17.2
	9	9.1	10.2	13.3	18.9	24.3	26.2	16.3

APPENDIX VII

Experiment 3

Frequency of correct response for words seen in the presence and absence of verbal context at all levels of exposure duration. Data from individual subjects for each of three replications are shown. Also shown are the mean values across the replications.

IC = Irrelevant context
RC = Relevant context
NC = No context

APPENDIX VII

Experiment 3

REPLICATION I

Ss	Context Condition	EXPOSURE DURATIONS 1	2	3	4	5	6
ZP	IC	.23	.50	.80	.87	1.00	
	RC	.10	.30	1.00	.80	1.00	
	NC	.20	.60	.90	1.00	1.00	
IK	IC	.37	.60	.97	.93	1.00	
	RC	.20	.50	1.00	1.00	1.00	
	NC	.20	.80	.80	.80	1.00	
IM	IC	.30	.67	.80	.77	.83	.93
	RC	.10	.70	.90	.80	.90	.90
	NC	.30	.50	.90	.90	.90	.90
RG	IC	.27	.57	.90	.93	1.00	
	RC	.10	.50	.80	1.00	1.00	
	NC	.10	.50	.70	1.00	1.00	
RSG	IC	.23	.67	.87	.87	.93	1.00
	RC	.10	.80	.80	.60	.90	1.00
	NC	.20	.70	.90	.70	.90	1.00
$\bar{x}$	IC	.28	.60	.87	.88	.95	.97
	RC	.12	.56	.90	.84	.96	.95
	NC	.20	.62	.84	.88	.96	.95

APPENDIX VII (CONTINUED)

Experiment 3

REPLICATION II

Ss	Context Condition	EXPOSURE DURATIONS 1	2	3	4	5	6
ZP	IC	.13	.63	.73	1.00	1.00	
	RC	.30	.50	.80	.90	1.00	
	NC	.10	.60	.60	1.00	1.00	
IK	IC	.20	.50	.90	.97	1.00	
	RC	.10	.50	.90	1.00	1.00	
	NC	.10	.30	.80	.90	1.00	
IM	IC	.30	.63	.77	.80	.83	.97
	RC	.30	.30	.80	.70	.80	.90
	NC	.20	.40	.70	.80	.90	.80
RG	IC	.27	.57	.57	.90	.97	
	RC	.30	.40	.50	.80	1.00	
	NC	.20	.20	.40	1.00	1.00	
RSG	IC	.17	.37	.73	.97	.97	.97
	RC	.10	.30	.70	1.00	.90	1.00
	NC	.20	.60	.80	1.00	.80	1.00
$\bar{x}$	IC	.21	.57	.71	.93	.95	.97
	RC	.22	.40	.74	.88	.94	.95
	NC	.14	.42	.62	.92	.94	.90

APPENDIX VII (CONTINUED)

Experiment 3

REPLICATION III

EXPOSURE DURATIONS

Ss	Context Condition	1	2	3	4	5	6
ZP	IC	.17	.47	.77	.87	1.00	
	RC	.40	.30	.70	.90	1.00	
	NC	.20	.50	.70	.80	1.00	
IK	IC	.13	.43	.87	1.00	1.00	
	RC	.00	.50	.80	1.00	1.00	
	NC	.10	.40	.90	1.00	.90	
IM	IC	.43	.67	.90	.87	.93	.93
	RC	.40	.80	.80	.90	.90	.90
	NC	.50	.60	.90	.80	1.00	.90
RG	IC	.27	.37	.63	.93	1.00	
	RC	.20	.30	.70	.90	1.00	
	NC	.10	.40	.80	.90	1.00	
RSG	IC	.17	.53	.60	.97	.93	1.00
	RC	.20	.50	.50	.80	.90	1.00
	NC	.10	.60	.60	.90	.80	1.00
$\bar{x}$	IC	.20	.49	.75	.93	.97	.97
	RC	.24	.48	.70	.90	.96	.95
	NC	.20	.50	.78	.84	.94	.95

APPENDIX VII (CONTINUED)

Experiment 3

MEANS FOR REPLICATIONS I, II, & III

		EXPOSURE DURATIONS					
Ss	Context Condition	1	2	3	4	5	6
ZP	IC	.18	.53	.77	.91	1.00	
	RC	.27	.37	.83	.87	1.00	
	NC	.17	.57	.73	.93	1.00	
IK	IC	.23	.51	.89	.97	1.00	
	RC	.10	.50	.90	1.00	1.00	
	NC	.13	.50	.83	.90	1.00	
IM	IC	.34	.66	.82	.81	.86	.94
	RC	.27	.60	.83	.80	.87	.90
	NC	.33	.50	.83	.83	.93	.87
RG	IC	.27	.50	.70	.92	.99	
	RC	.20	.40	.67	.90	1.00	
	NC	.13	.37	.63	.97	1.00	
RSG	IC	.19	.52	.73	.94	.94	.99
	RC	.13	.53	.67	.80	.90	1.00
	NC	.17	.63	.77	.87	.83	1.00
$\bar{x}$	IC	.24	.56	.78	.91	.96	.97
	RC	.19	.48	.78	.87	.95	.95
	NC	.18	.51	.75	.88	.95	.94

Appendix VIII

Experiment 3

Analysis of variance of mean proportion of correct response for words seen in relevant and irrelevant contexts as a function of exposure duration. The analysis was performed on the grouped data from all subjects and replications.

APPENDIX VIII

Experiment 3

Source	SS	df	MS	F
Between Ss	336.66	4	84.17	1.58
Within Ss	42,548.60	50		
Exposure Duration (ED)	40,288.41	5	8,057.68	152.18*
Context Conditions (CC) Relevant-Irrelevant	118.89	1	118.89	2.25 NS
ED x CC	76.26	5	15.25	1 NS
Error	2,065.04	39	52.95	
Total	42,885.26	54		

* $p < .05$

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